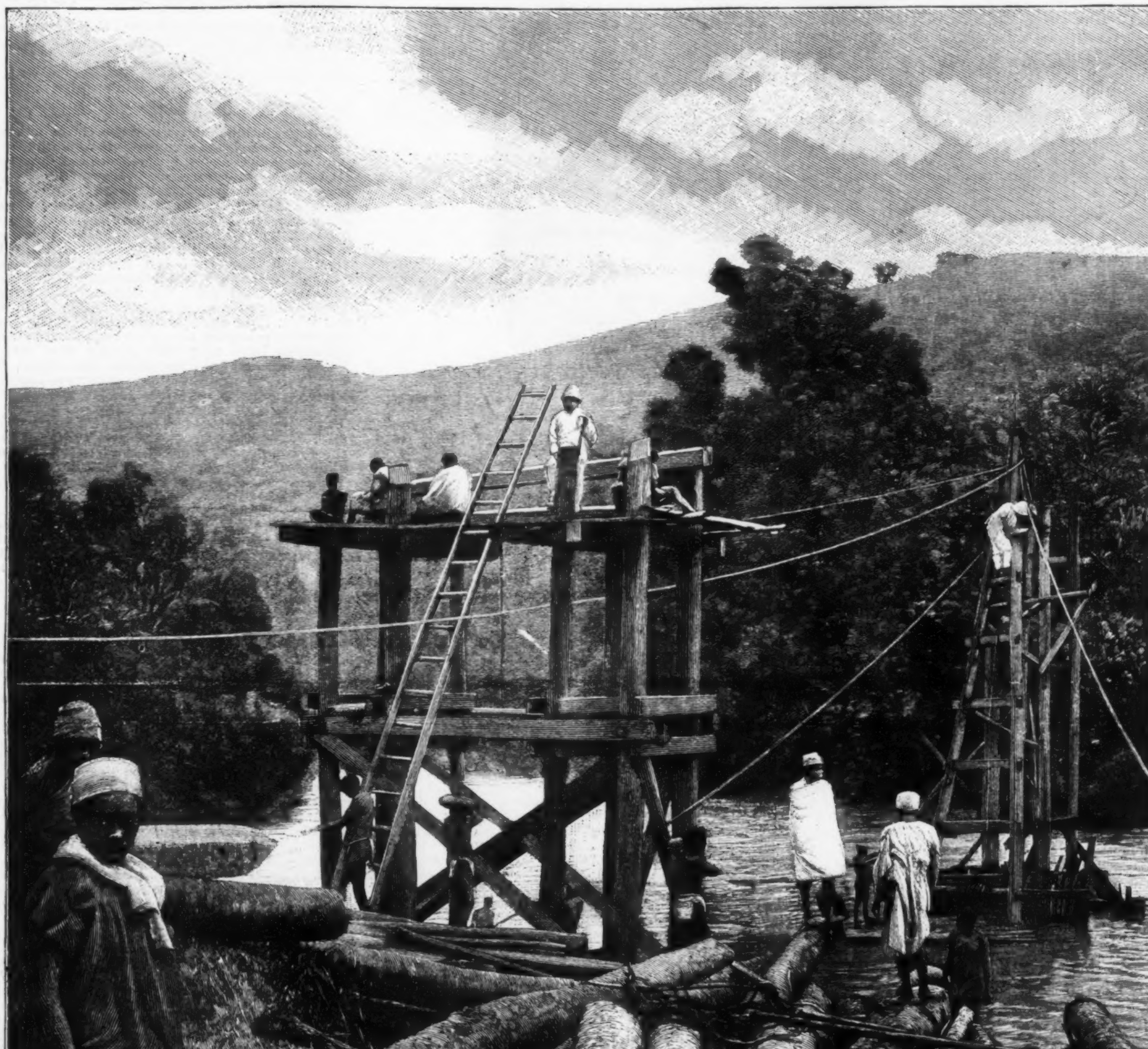
SCIENTIFIC AMERICAN SUPPLEMENT. No 1227

Scientific American, established 1845.
Scientific American Supplement. Vol. XLVIII. No. 1227.

NEW YORK, JULY 8, 1899.

Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.



CONSTRUCTION OF A BRIDGE OVER THE MAHELA RIVER, MADAGASCAR.

THE WORK OF GENERAL GALLIENI IN MADAGASCAR.

THE distance from Tamatave to Andevorante on the Indian Ocean side of the island of Madagascar is sixty miles, and the only means of communication between the two places at present is by rail to Ivondro and then by wagon over the old Malagache road that extends along the coast. The trip takes about two and a half days. Andevorante, which is located between the tributary lagoon of Iaroka and the ocean, upon the margin of marshes that will soon be drained by colonization, is a small town of straw huts at which land barges that are loaded to the gunwale with merchandise which they have brought through the breakers from steamers, sailing vessels and Arabian "bouters" anchored in the roadstead. This town, with Tamatave and Vatomandry, is one of the bases that supply Emyrne by the east coast. The Malagache wagon road just mentioned is soon to be replaced by a waterway; for the lagoons along the coast are to be united with the rivers so as to form a canal that will afford a continuous passage for small steamers. This navigation will continue through Iaroka from Andevorante to Mahatsara. Mahatsara is the limit of navigability of the river to five or six miles upstream, and it is here that begins the great roadway. Travelers upon landing do not as yet find here the hoped-for automobile, but that will come in course of time.

ACCOMMODATIONS FOR TRAVELERS ON THE ROAD BETWEEN TAMATAVE AND ANDEVORANTE.

Vehicles belonging to the engineering service are already running over the road, and in one of these, drawn by four mules, General Gallieni, upon his return from a tour of the island last October, made the first thirty miles of the eastern section at a very satisfactory speed.

It is unnecessary to say that the future of the French colony is connected with the opening up of great ways of communication and that, in awaiting the construction of a railway, a good public road must be provided; not a simple roadway subject to periodical degradations and utilizable only at certain epochs, but a macadamized road of adequate and constant width, with gradients and curves that never exceed the maximum of inclination nor the minimum of radius prescribed by a severe programme—a road, in fact, adapted for commerce, and over which vehicles may pass at all times.

It is under such circumstances that is now constructing, at several points at once, the east coast road, which, in a near future, will connect Tananarive with Mahatsara and consequently with Tamatave. General Gallieni has intrusted the construction of this to the engineering service, and, for the temporary use of travelers, has provided, here and there along the route, a plainly furnished hut where a night's lodging may be had. The supreme direction of the entire work has been confided to Lieutenant-Colonel Rocques of the government engineers. The supervising of the work is done by officers of the engineer corps and of the army, and the force of laborers is recruited from the population.

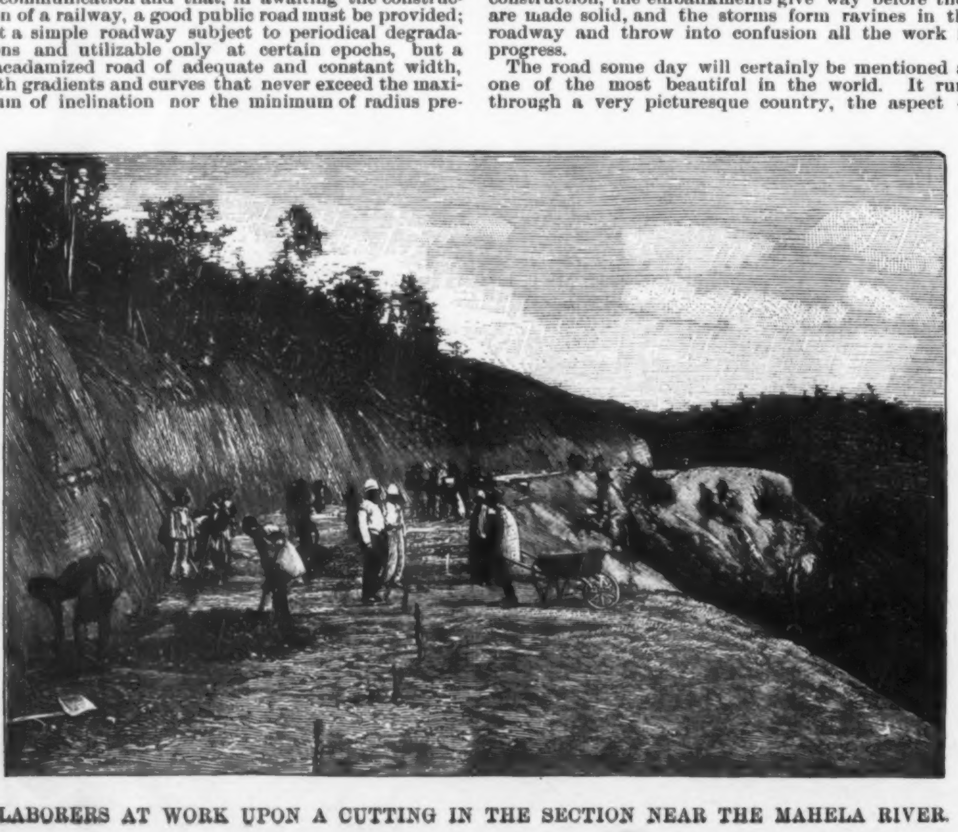
In traversing in succession the various working points, which become more and more animate in measure as we approach the present terminus upon this section, at about thirty miles from Mahatsara, we pass over a road 16 feet in width, 10 feet of which is macadamized, and the whole of which is laid out with the greatest care and is at all points comparable with the beautiful roadways of the Alps. It is, in fact, a mountain road, since the country through which it passes is very undulating and rapidly rises.

The work is proceeding well enough just now, but how many days in the year can it be carried on upon this eastern slope? Rain is constantly falling, the vicinity of the high and wooded crests that form a barrier to the vapors of the ocean profoundly modify the general climate, and the wet season is prolonged very late, to the detriment of the dry. How much trouble and inconvenience, and how many deprivations for the humble pioneers who are doing the work! The bridges are threatened by freshets during their construction, the embankments give way before they are made solid, and the storms form ravines in the roadway and throw into confusion all the work in progress.

The road some day will certainly be mentioned as one of the most beautiful in the world. It runs through a very picturesque country, the aspect of which varies from hour to hour in measure as one gets further away from the seaboard. First we observe dales and rice fields, and marshes stocked with game, and then ever-verdant hillocks crowned with superb mangrove trees, the dense masses of which recall the chestnut trees of certain baronial estates of France. At several localities recent concessions are beginning to be profitably worked, and here we see herds of fine horned cattle confined in yards encircled by bamboo fences. We pass through small villages, of which the inhabitants are standing upon their thresholds selling wine, tapioca, small sun-dried fish, bananas, lemons, huge grape fruits, and cordage made from the rofia, a sort of large palm that grows in the low regions. We cross beautiful rivers of clear and torrential water over wooden frame bridges that are destined to be replaced by others of iron, but which are nevertheless so constructed as to be capable of supporting very heavy loads.

After passing through the localities where the creole or negro laborers are at work making planks or putting down or sanding the ballasting, which cannot yet be crushed for want of powerful rollers, we descend to the great river of Mahela (an affluent of the Iaroka) which the old Bourjane trail, as well as a mule path, cross through a deep ford that is impracticable at high water for days at a time. The road, which afterward continues along steep declivities covered with a dense vegetation, is now nearly completed as far as to Ampasimbe.

For the above particulars and the engravings, we are indebted to Le Monde Illustré.



LABORERS AT WORK UPON A CUTTING IN THE SECTION NEAR THE MAHELA RIVER.

NAVAL ARCHITECTURE.

By VERNON D. COX.

THE exceptional activity in the construction department of the navy, the increase in the number of our fighting ships, and the prospect of a larger seagoing trade between our country, Hawaii, Porto Rico, and other colonies, direct attention to the art and practice of shipbuilding—the work of the naval architect—one of the most interesting though least known of the professions.

The subject of shipbuilding is divided into two portions, the theoretical and the practical, the former having reference to the designing of vessels, the latter to their construction. Within the limits of this article we can only give a general idea of both branches of the work. The naval architect designs the form of a ship with reference to the object of her construction. All ships have to possess certain qualities, such as buoyancy, stability, handiness, and speed; but it is hardly possible for any ship to possess at the same time the maximum of all these, as, to some extent, they neutralize each other.

It is the business of the naval architect to duly proportion them one to another, ascertaining which are the more important in each particular case, and providing these without unduly impairing the others. When a vessel works only in smooth water, her degree of stability or freedom from excessive rolling and tendency to right herself when encountering a wave may be secondary in importance if speed is desired. In others, which have to weather long-continued storms in midocean, speed may have to be sacrificed to attain greater steadiness. The genius of the naval architect lies largely in the one word "form." He aims to have a reputation to give a good shape to the mass of wood or iron coming from his hands, whether it be a man-of-war or a sailboat. The naval architect stands in the same relation to ship building that the architect of houses does to house building, with this difference, not only does he make the plan, but very often he executes it as well.

The naval architect, before commencing the theoretical part of his studies, must have a good knowledge of arithmetic and algebra, also seven books in Euclid, with special reference to proficiency in the fourth and seventh books. His first work in the office of the naval architect where he studies the profession is, probably, drawing the midship or central section of a boat, to which he is required to put a body, giving it a bow, a stern—in short, giving to the boat its form. After awhile he will be able to make the full design of a vessel. The cost of his technical instruction will amount to \$1,000, though it may be several hundred dollars less if he has given his services as draughtsman to his instructor. His case of drawing instruments will cost from \$50 to \$250, depending upon the number of instruments, the manner in which they are finished, etc.

As the naval architect works on paper only, he must show on a flat surface, for the builder's guidance, the exact position, curvature, and relief of every line and point in the proposed structure. He accordingly draws three plans, on each of which every point of the ship is traceable—the sheer plan, showing all lines of length and height; the body plan, giving the shape of the vertical transverse sections; and the half breadth plan, giving the projections of transverse longitudinal sections. From these combinations the exact position of every point is determinable. But, in addition to these, the architect furnishes the builder with the elevations, plans, and sections of the interior parts of the ship, and of the framing and plating, or planking. To gain a rough idea of the plans referred to, take a cucumber, decide which you will call the bottom and which the top, and cut it in the middle lengthwise, from end to end. Look into its interior and fancy that it is covered with lines, both horizontal and vertical, and that will give you a very rough idea of the sheer plan. By laying the cucumber on its side and cutting it lengthwise, you will have a notion of the half breadth plan; a division in the middle may suggest to you the body plan. This cannot be made very clear, not even with drawings, because it is the most technical part of the work; but its object is apparent.

The thicknesses or weights of all the component parts are specified in a detailed specification in order that the ship when completed may have the precise weight and position of center of gravity contemplated. In the case of ships built for the navy, the building materials are weighed before they are put into place. As each section of the work is completed, the weight is compared with the designer's estimate. As soon as the incomplete hull is floated, the actual displacement is measured and compared with the weights recorded

as having gone into the ship. When completed, if ships float at a deeper draught than was intended, or are found to be more or less stable than was wished, this is usually due to additions and alterations made after the completion of the design.

An increase in length gives an increase of displacement of water, and therefore of carrying power; if this be not desired, it allows of finer lines forward and aft, and consequently greater speed. It also increases the resistance to leeway. The greater friction of the water on the longer sides does not appear to be material. Against the increase is to be set a diminished power of turning, tacking, and wearing. It also involves a more careful balancing of weights in the fore and after portions of the ship.

The increase of breadth gives greater stability to the ship, and, in a sailing vessel, by allowing more sail, indirectly gives greater speed; but directly it increases the resistance to the water. Of course, greater breadth enables greater bulk to be carried. Depth is a question dependent on the seas to be navigated, the object for which the ship is intended, and many other reasons. It must be borne in mind that the consumption of stores on a long voyage will change the draught of a ship considerably.

In addition to the construction drawings which have been referred to, it is usual also to prepare a small wooden model of the ship which will give an idea of what she is going to look like better than flat paper can do.

"A little model the master wrought,
Which should be to the larger plan
What the child is to the man."

This model is made of a number of horizontal layers of wood, and upon it the whole arrangement of the plating of the ship is marked, with the position of all the joints, etc.

The first work of construction is to make plans of the ship on the floor of a long, wide room, like a big garret, which is used especially for this purpose. The preparation of the shipway is another important feature of the work. A number of strong blocks of timber are placed a short distance apart, on which the keel shall rest, and which shall sustain the entire ship when built. A line of inclination of five-eighths of an inch to a foot is preserved for the facility it affords in launching the completed vessel. On the blocks is laid the keel or the backbone of the ship. From it start the ribs, the stem, and the sternpost; so that any serious accident happening to the keel involves the breaking up of the whole structure. What the keel is to the bottom the stem and sternpost are to the bow and stern of the ship, forming the keys from which the ends of the planking (technically called the "butts") and all longitudinal supports start.

The extreme outlines of the ship having been established, the builder proceeds with the timbers to form the bottom and sides, which together constitute the frame, corresponding to the ribs of an animal. The ship is divided into fore and aft bodies, separated by an imaginary athwartship section at the widest part of the ship. The midship body refers to an indefinite length of the middle part longitudinally, including a portion of the fore body and the after body. The term "timbers" generally refers to the frames. The keel, the floors, the beams, are terms which describe themselves. The shelves are longitudinal pieces of timber worked around the interior for the purpose of receiving the ends of the beams of the several decks. The planking or sheathing of the vessel is called its skin. The ribs in an iron ship are called frames. They are bent while red hot, upon a large flat cast iron plate, into the proper curve, and set in place upon the keel.

Iron ships are always divided into a number of compartments by transverse partitions called "bulkheads." These partitions can easily be made watertight, and then afford greater security to the vessel, as, in the event of a leak occurring, it will often be possible to confine the water to the space between two bulkheads, and there will be sufficient buoyancy in the other compartments to keep the vessel afloat. The bulkheads are fitted with watertight doors, which are a source of safety and also a great additional transverse strength.

A great deal of calculation and figuring enters into the work of the naval architect, but much of it has been made easy by the aid of a book called "Simpson's Rules." These rules are incorporated in small pocket handbooks which contain, in addition, a large number of tables, rules, and formulas pertaining to naval architecture. The most popular handbook of this character in England is said to be "Makrow's Naval Architect and Shipbuilder's Assistant," and in our country, "Haswell's Engineers' Pocketbook of Tables." These and other similar books, however, are only aids in making calculations, and are very much like the interest tables used in banks, which save the trouble of going through the figuring in detail. There is a large literature of special interest and value to the naval architect and those practically engaged in shipbuilding. Some idea of the technical character of these books may be gained from the following headings in the table of contents of a standard work of this kind: "The Displacement and Buoyancy of Ships," "The Oscillation of Ships in Still Water," "The Oscillation of Ships Among Waves," "Methods of Observing the Rolling and Pitching Motions of Ships," "The Structural Strength of Ships," etc.—The Independent.

The South Park board of commissioners of Chicago has forbidden the use of the parks and the boulevards (within its jurisdiction) by horseless carriages, and the police have been instructed to keep such vehicles off the forbidden ground. The principal reason for this action is the danger to cyclists, pedestrians and others which results from the frightening of animals at the sight of an automobile. In addition to this it is claimed that difficulty is had in compelling the drivers of automobile carriages to run within the legal rate of speed, especially at night. Of late, automobile carriages have become very numerous in the parks and on the boulevards in the south side of Chicago, and it is said that many business houses have bought automobiles to be used in delivering goods, in order to obtain a vehicle which would be permitted on the boulevards, instead of having to drive through the alleys, as dray wagons are compelled to do.—Railway Review.

ROSA BONHEUR.

THE great artist who died on May 25, after a short illness, was born in Bordeaux, in 1822. She was seven years old when her father, a painter of merit, went to live in Paris. Although still very young, she showed a precocious aptitude for painting. Her vocation was thus determined, and she developed and perfected herself in it by hard work, studying the masters in the Louvre and making copies of them, the ready sale of which encouraged her.

In 1845, at the age of twenty-three, two of her paintings—"Goats and Sheep" and "Rabbits"—were admitted to the Salon. This début was modest enough, but besides attesting the quality of her work, it showed the young woman's well-chosen intention of classing herself among the animal painters. Two years later her "Red Oxen of Cantal" won for her a third-class medal.

In 1848 the state bought her "Plowing in Nivernaise," which is now in the Luxemburg.

It was not long before Rosa Bonheur was in receipt of numerous orders. With all her accuracy of detail and care in composition, she was not lacking in productiveness. By her art, which she practiced with laborious regularity, she produced many paintings, especially for Belgium, Germany, England and America, where her pictures sold at high prices.

In 1865 she received the Cross of the Legion of Honor from the Empress, and in 1893 President Carnot promoted her to the grade of officer. She was also awarded numerous foreign honors.

After not having taken part in French exhibitions for a long time she at last decided to send a canvas to this year's Salon, in which was also hung her portrait. Some days before her death, there was talk of awarding her the medal of honor. She wrote a very dignified letter, declining this distinction, which, she said, seemed to her out of all proportion to the importance of the work she had submitted.

Rosa Bonheur died at By, near Thommery, at the edge of the Forest of Fontainebleau, in the chateau where for the last forty years she had led a retired existence, working to the end, and doing the little kindnesses which so endeared her to the country folk.—L'Illustration.

ROSA BONHEUR.

TWO CENTURIES OF TEA.

WHILE investigating the history of tea, an English writer came across a rare manuscript in the British Museum giving a quaint summary of the virtues of the herb called tea or chée. It was dated October 20, 1686, and purported to be a translation from the Chinese, as follows:

1. It purifies the Blood that which is Grosse and Heavy.
2. It vanquisheth heavy Dreams.
3. It easeth the Brain of heavy Damps.
4. Easeth and Cureth giddiness and pains in the Heade.
5. Prevents the Dropsie.
6. Drieth moist humors in the Heade.
7. Consumes Rawnesse.
8. Opens Obstructions.
9. Clears the Sight.
10. Cleanseth and Purifieth humors and hot Liver.
11. Purifieth defects of the bladder and Kidneys.
12. Vanquishes superfluous Sleep.
13. Drives away dizziness, makes one nimble and Valiant.
14. Encourages the Heart and drives away Feare.
15. Drives away paines of the Collick.
16. Strengthens the inward parts and quickens the understanding.
17. Strengthens the Memory.
18. Sharpens the will and quickens the understanding.
19. Purges safely the Gaul.
20. Strengthens the use of due benevolence.

From the foregoing it seems that the "cup that cheers" was a beverage very highly esteemed in England 200 years ago. Its introduction was an event of great significance. Its medicinal and wholesome qualities had been proclaimed in advance, and its arrival was hailed with delight as a substitute for intoxicants.

Tea did not become a popular beverage for a long period, as the masses were precluded from drinking it by reason of its exorbitant price. The Dutch East India Company monopolized the traffic and supplied the limited demand for many years. Later, when England and other nations effected treaties with China, tea became an extensive article of commerce in Europe. It figured conspicuously as a bone of contention between the mother country and her colonies in 1773 in Boston and other ports. It was a luxury enjoyed by the aristocracy in the colonies up to 1790, in which year 88 pounds were imported direct from China in an American vessel. In the next decade the entire importation was 1,343 pounds. In 1801-02 came 9,451 pounds; in 1815-16 came 20,820 pounds. A portion of this was exported to England. The consumption in 1820 was less than one-half pound per capita. From this date up to 1850 the importations were about equal to the consumption, which had increased to 1·22 pounds per capita.

At this period the treaty ports, namely, Foo-Choo, Shanghai, Amoy, Hongkong, and Canton, were declared open. The influx of China's productions increased slowly, as the transportation was made in old hulks, which required from twelve to fourteen months for each voyage. Later, the clipper ships replaced these, and the time was lessened to five months. The Suez Canal reduced the time to sixty days, and now the Pacific Mail steamers and railroads deliver goods from China and Japan in this city within thirty days.

Previous to 1856 China produced nine-tenths of all the tea grown. The varieties comprised green, English breakfast, or Congow, Oolong, Powchong, and Bohea. The advent of Japanese tea in 1855-56 opened a new feature in the United States markets. Its first appearance was not inviting, as it was uncolored, and was packed in uncouth wooden boxes, unmatted. The science of preparation was then unknown to the Japanese. There was apparently no limit to the production of this tea, and its cup quality was delicious. When a treaty was concluded with Japan in 1859, Americans gained access to the tea markets of that country, and without delay proceeded to manipulate the leaf so as to make it more acceptable in our markets. The distinctive feature of the tea in infusion popularized it, and the demand soon exceeded that of all other kinds. This remained the case for a number of years.

In 1869 Formosa tea was introduced here direct from the virgin soil. Its advent produced no little excitement, as the tea was superior in every respect to any then imported. When it was exposed in bulk it filled the room with a delightful odor, and from the infusion came a flavor resembling the extract of flowers—a perfect bouquet—the higher grades excelling in this respect. This character of tea is in greater demand and consumption in excess of all other kinds.

The tea is picked each year from May to September. The first picking is in May, the second in June and July, and the third in August and September. The latter comprises inferior grades and refuse.

During the civil war Congress imposed a duty of 20 cents per pound on tea. Gradually prices advanced, until the best grades of green tea sold from first hands at \$1.50 to \$2.50 a pound. The lowest grade was 90 cents; Formosas, \$1.75; Foo-Choo, \$1.50; Amoy Oolongs, \$1 to \$1.25, etc. These prices were maintained until the duty was removed in 1872, from which time prices declined down to 1883, when the Tea Adulteration bill became a law. Under the operation of this law millions of pounds of tea unfit for consumption were rejected. The government appointed examiners for the ports of New York, Boston, Chicago, San Francisco,

and Tacoma. Under their supervision the rejections were submitted to a Board of Arbitrators. If their rejections were sustained, the tea was reshipped or destroyed. Like most laws a way was found to evade it, and relief was sought and found in the Standard law of April, 1897. This proved to be a sanitary measure, and no impure or unwholesome tea is now admitted. This law was rendered necessary by the fact that foreign capital was largely employed to throw upon the markets of this country the refuse and impure stock from China and Japan. No other country would admit it. No other country admitted tea free of duty.

Previous to 1875 all engaged in the importation of tea prospered and made fortunes. During the civil war and up to that date every dollar invested paid from 25 to 100 per cent. profit; since, there have been very few years when the profits exceeded the losses. Some of the largest and oldest houses in China have been wrecked in the last decade, such as Russell & Company, Colgate, Baker & Company, and Adamson, Bell & Company. These failures forced many here to retire. Many dealers of prominence in the trade here twenty years ago were forced into retirement and are forgotten.

The increased production of tea in Ceylon and India during the last ten years, in addition to that from China and Japan, has tended to depress values. A review of the yearly importations for twenty years is interesting: In 1875 this country received 63,000,000 pounds, value $22,000,000; in 1890 the receipts were 83,000,000 pounds, and the value $16,000,000; in 1895 the figures were 98,000,000 pounds, and the value $13,000,000; in 1896, 110,000,000 pounds and $13,500,000 in value, and in 1897, 93,000,000 pounds and $12,000,000 in value.

It will be observed that receipts increased 75 per cent. and values decreased 45 per cent. This is largely accounted for in the excess of inferior goods.

The consumption in the United States in 1896 was 100,000,000 pounds, or about 1·36 pounds per capita. At the same time, in England and her possessions, 221,000,000 pounds were used, or 5·65 pounds per capita.

It may be of interest to many to know the rates of duty on tea imposed by the United States from 1816 to 1872. These were as follows: In 1816, transported by United States vessels, 28 cents a pound; by foreign vessels, 38 cents a pound. This was changed in 1830 to 12 cents in the case of United States vessels and 20 cents in the case of foreign vessels. From 1832 to 1842, when entering by United States vessels, tea was admitted free, when on foreign vessels the duty was 10 cents a pound. During the civil war, on August 5, 1861, a 15-cent duty was imposed. December 24, 1861, it was changed to 20 cents. June 30, 1864, an additional 5 cents was added, making it 25 cents. This rate was continued to July 14, 1870, when it was reduced to 15 cents a pound. May 1, 1872, it was made free, and until June 13, 1898, it was exempt from duty.—J. A. in New York Times.

[Continued from SUPPLEMENT, No. 1226, page 19653.]

A FEW SPIDERS AND THEIR SPINNING WORK.*

IN the United States we have two species of the genus Argiope—Argiope cophinaria, the Basket Argiope, and Argiope argyiaspis, the Banded Argiope. Both are abundant in our fields and lawns in autumn, and may be easily recognized by their beautiful markings and large size. Their habits and spinning work are similar, but some differences appear (Fig. 8).

The Basket Argiope is the largest of our orbweavers, and its web is frequently very large; but this is regulated by the site. The peculiarity that you may first notice is the oval shield of white silk tissue that covers the hub. In the adult spider it is usually about two inches long by one and a half wide. Attached to the shield is a zigzag ribbon of white silk extending both upward and downward between two radii. Another interesting feature of this snare is the protective wings or fender. (Fig. 9.)

FIG. 8.—ARGIOPE COPHINARIA.

These are sometimes found on either side of the orb and at a distance of a few inches from it.

Fig. 10, the Banded Argiope, is smaller than the Basket Argiope, and is readily distinguished by the pretty black and yellow bands which cross the abdomen. It is seen most frequently in late summer and until November. Its snares are to be found on hedges, shrubs, tall grasses, and weeds. The sheeted hub is not so large nor the tissue so thick as that of the Basket Argiope, and the zigzag cords are often of a more fanciful pattern, at times being thrown in arcs around the hub. Both Argiopes are usually found on their snares.

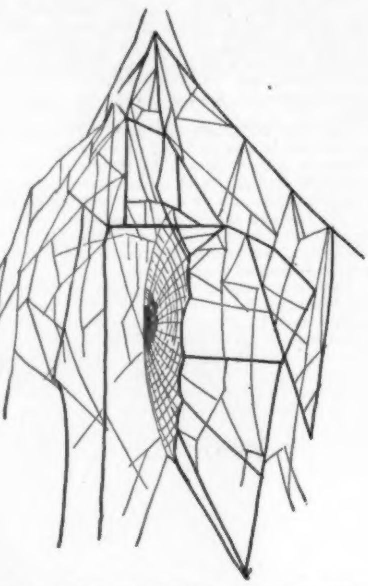


FIG. 9.—PROTECTIVE WINGS OR FENDER OF ARGIOPE COPHINARIA.

Among orbwebs most frequently seen are those of a group called Epeira (Fig. 12).

Fig. 12 is a typical web. The most common here of these are Epeira strix, Epeira insularis, and Epeira trifolium. Their webs are all quite similar and have meshed hubs. The notched zone has from four to six concentrics, while the radii and spirals are usually in the neighborhood of twenty-one. None of the orbweavers more habitually shun the light, it being rarely found on the snare during the day, but occupies a neighboring crevice or rolled leaf.

The third group of orbweavers making vertical snares is composed of those retaining the open hub. Among these are our indigenous species of the genus Acrosoma. The favorite site for their snares is a large open space between bushes or trees. They are usually swung at a considerable height. The foundation lines are frequently very long, and the delicate orb swung between them is a pretty sight outlined against the sky or trees. The three spiders common to our neighborhood make substantially the same web. The shape of the snare more nearly approaches a circle than any other species of orbweavers. The number of radii is very great, often amounting to eighty, and the spirals are correspondingly large. The orb itself is small, often not exceeding six inches. The hub is always open, and within this the spider can usually be found hanging with its legs outstretched, grasping the margin of the hub.

The Labyrinth Spider weaves a composite orb; that is, it combines the round web of the orbweavers with the netted maze of the lineweavers. The orb is spun at one side and is separated by a small space from the maze or labyrinth in which is found its silken tent, often hidden under or built against a leaf. The trap line differs from that of Trifolium and Insularis in being composed of several threads instead of a single line. The maze is a matter of growth; for after the spider has established a few lines it will place itself in their center and proceed to build the dome. Here it establishes itself, stretches out its trap lines, and proceeds to spin the orb. There is a marked peculiarity in the choice of a favorite site for this snare, which is nearly always found on a dead twig or leafless branch, and little colonies are often found building their snares near together.

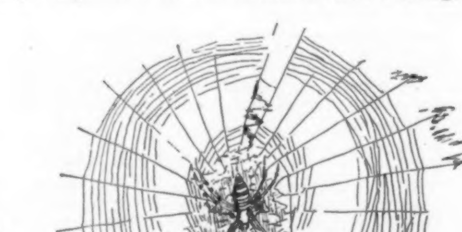


FIG. 10.—ARGIOPE ARGYIASPIS.

Fig. 14.—Closely allied to these are the sectoral orbs. These have an open sector and one free radius which serves as the trap line leading directly to the tent of the spider.

Fig. 15.—There is sometimes an open and quite distinct tube attached to the mouth of the tent and reaching almost to the center of the orb—a suggestion of the typical snare of the tubeweavers.

Fig. 16.—Among horizontal snares, that of the Orchard Spider is quite familiar. It is spun on the grass or weeds or the lower branches of shrubs. The orb is round, the hub open, and the spider's position is just beneath, clinging head downward to the margin of the hub.

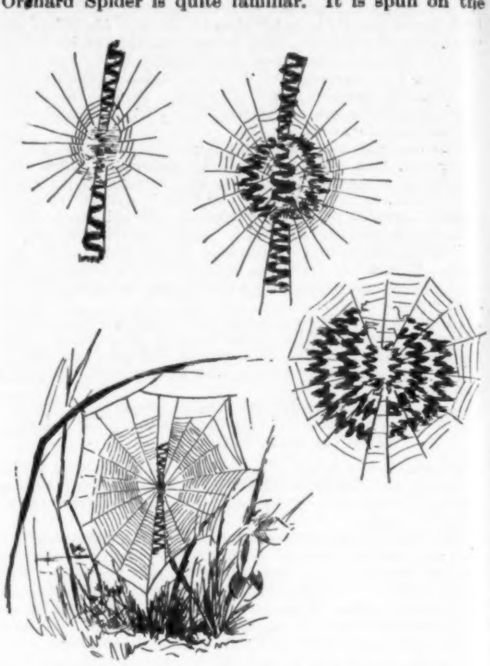


FIG. 11.—HUBS AND WEB OF ARGIOPE ARGYIASPIS.

The orb of Tetragnatha extensa corresponds very closely with that of the Orchard Spider; but it is usually found near water. Its position on the orb, with feet outstretched front and back across the hub, is usually quite enough for identification.

Fig. 17.—The Triangle Spider, Hyptiotes cavaties, has awakened great interest on account of the peculiar manner in which it operates its snare. This is a sector of a circle including about forty-five degrees. It is spun in a vertical plane and principally on pine trees, notably the dry, bare branches quite near the ground. Hyptiotes is very small, perhaps not over an eighth of an inch in body length, with short, stout legs. It is of a dull grayish brown color, intermingled with tints of red, and its general color so resembles the dead branches, it is very difficult to find. The position of the spider upon the trap line is very peculiar. The face and forefeet are toward the snare. The line is held within the first two pairs of claws and drawn so tightly that every part of the web is perfectly taut. The third and fourth pair of feet also clasp the line; but between them, instead of being held tight, the line has the appearance of a coil. This is in reality the means by which the net is sprung. When the spider perceives that its prey has touched the net, it instantly releases the forefeet and those of the third pair which kept the relaxed coil. The net is by this means thrown forward and around the insect and its entanglement secured.

Thus we have around us most deft and cunning workmen in the usually despised children of Arachne, a study of whose every-day lives would surely tend to show that a greater measure of respect is their due.

FIG. 12.—TYPICAL ORB OF EPEIRA.

* A paper read by Miss Mary I. Cunningham at the Bucks County Natural Science Association's summer meeting, at Buckingham, Pa., June 3, 1899. Revised for the SCIENTIFIC AMERICAN SUPPLEMENT by the author.

GEMS OF MAINE.

FROM a paper on "The Minerals of Maine," prepared by E. R. Chadbourn, of Lewiston, Me., at the request of the Murray Club, of that city, the following notes concerning the gem stones are extracted:

The most beautiful product of the Maine rocks is the tourmaline. This is the queen of American gems, the stone that it has been proposed to adopt as the national gem, and the extraordinary specimens from

FIG. 13.—LABYRINTH SPIDER.

these rocks surpass those of other American localities, if not those of the world, in rarity and beauty. No other mineral has such a range of color, every tint of the rainbow being represented in its crystals. Not only this, but the combinations of colors sometimes seen in single crystals are the marvel of the mineralogist. Some of these crystals are red, white and blue; and in some wonderful crystals, found in 1866 and 1881, the top is of green, the center of white, which passes into pink further down, while the base is of indigo blue. In others, the colors are simply red and green, or white and green, with many intermediate shades. In still others, the interior has a different color from the outside, as a red core in a green shell, and a crystal showing a single color on the outside may have a curious variety of tints inside. The mineral has a complex composition, being essentially a silicate of aluminum and boron, with varying proportions of iron,

FIG. 14.—COMPOSITE ORB; SECTORAL ORB.

manganese and lithium. It has very interesting properties, such as an extraordinary dichroism, or property of appearing differently colored when viewed from different directions; an unusual pyro-electric capacity, receiving opposite charges of electricity at the two ends on being moderately heated; the power of polarizing light, and that of double refraction, with which we are most familiar in Iceland spar.

The first tourmalines at Mount Mica, in Paris, were found in 1820, by two students—one a brother of Hannibal Hamlin, the civil war Vice-President. These young men soon obtained about thirty small crystals, part of which were afterward lost, and have since reappeared in the Imperial Cabinet of Minerals at Vienna. In 1825 the place was visited by Prof. Charles U. Shepard, whose collection of minerals at one time was unsurpassed in America. He obtained some of the finest specimens of the tourmalines ever found, most of which are now preserved at Amherst College. From the lot he has cut a grass-green gem, about an inch long and three-fourths of an inch broad, a marvelous

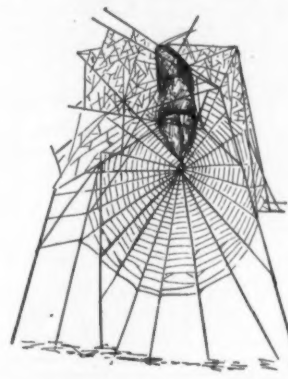


FIG. 15.—SNARE OF SECTORAL ORB, WITH TUBE ATTACHED.

red gem of similar size, and a white one two-thirds as large.

Since 1881 mining has been carried on by the Mount Mica Company. The work was at first done at irregular intervals, but it has been continued each season since 1890, giving to Maine one of the very few systematically operated gem mines in America. Most of the crystals are small, but it has been estimated that from 100 to 200 of the many thousands found here would be considered remarkable specimens of the mineral. The largest transparent green crystal known was found in 1886. It is 10 inches long, $2\frac{1}{4}$ in diameter, weighs 41

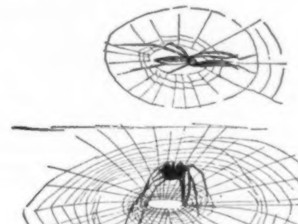


FIG. 16.—SNARE OF ORCHARD SPIDER (TETRAGNATHA EXTENSA).

ounces, and, with both terminations preserved, it is now in the collection at Harvard University. In the same cabinet is the most remarkable known white tourmaline, or achroite. This was found in 1869, and is white at the top, shading into smoky color toward the base, but is crimson when viewed along the axis, and the terminations are tipped with green. The finest known blue tourmaline, or indicolite, is in the Hamlin collection. This was broken into five pieces when found, but has been restored, with both terminations complete. It is transparent, and sapphire-blue in color, changing into green at the top.

FIG. 17.—SNARE OF HYPTIOTES CAVATIES. SPIDER ON TRAP LINE.

A crystal from the find of 1893 was sold to Tiffany, of New York, for $1,000. One priced much higher was found in the fall of 1897, this being about 9 inches long, with a transparent nodule at the tip 2 by $1\frac{5}{8}$ inches in size, and capable of cutting a magnificent green gem of about 80 carats, with several smaller ones. It is the finest specimen of the kind ever known.

Among the crystals obtained last year were two red and green ones, 9 or 10 inches long and 3 inches or more in diameter, of little value for gems, but splendid cabinet specimens. The season's yield also included some fine gem crystals of blue-green and red, the color of some of the crystals being pink at the base, changing into a clear green, with a band of yellow-green in the middle of the prism. One crystal, 6 inches long and over an inch in diameter, was of a fine transparent blue, terminated at the base with an inch of red.

Dr. Hamlin, of Bangor, president of the Mount Mica Company, an authority on the tourmaline, has secured a large portion of the fine crystals from Mount Mica, forming by far the finest collection of tourmalines in the world, much of which has lately passed into possession of Harvard University.

In Auburn, near the Minot line, a boy named Lane picked up in 1862 a piece of what seemed green glass. He took it to his home, where it was seen by Dr. Luther Hill, who recognized in it a tourmaline fragment. The locality since known as Mount Apatite was thus discovered, and long afterward produced several thousand dollars' worth of fine tourmalines. The search was continued intermittently for many years. This place is now worked as a feldspar quarry, and the operations of the last two or three years have yielded some interesting discoveries. One of these was a find of herderite in the finest crystals known. This mineral was found in Saxony, prior to 1825, but in recent years has been obtained only at few localities in Maine, and only at Auburn in the exquisite brown crystals with transparent tops that well might lead the gem lover to look for a fresh addition to his list of fine stones. The hardness, however, is not sufficient for gems, being only 5, while that of quartz, whose varieties supply some of the softer gems, is 7.

Near by, on Mount Apatite also, a large pocket of smoky quartz was opened in the fall of 1897, and from this has been taken a large quantity of material of extraordinary quality, including transparent smoky crystals, with polished faces of a brilliant black by reflected light, up to 100 pounds in weight, and transparent yellow quartz of superb color for cutting into ornaments. The showy appearance of this quartz led to considerable local excitement.

The tourmalines are the only Maine gem stones of importance. The beryl is one of the common minerals, and is sometimes found in bluish-green crystals, with transparent spots, from which are cut aquamarines. Of such gems Maine has furnished notable specimens. One from Stoneham is the finest ever found in the United States, the cut stone being an inch and two-fifths in each diameter, and weighing $133\frac{3}{4}$ carats. Remarkable beryls have been obtained at Topsham. Doubly terminated crystals, five inches long and an inch through, showing considerable transparency and of great beauty, have been found, the colors being green, yellow and white. Deep green ones, discovered last year, may be ranked as emeralds, although of little or no gem value—the emerald being a variety of beryl usually supposed to exist at no American locality except North Carolina. A few of the beryls are of great size, one found on Mount Apatite, two or three years ago, having been about 20 inches in diameter and 12 feet or more long.

The best topaz crystals of the Eastern States have been secured at Stoneham, which is one of the several topaz localities in New England. Some opaque crystals are a foot across, the finest ones being much smaller, and cutting perfect gems, colorless or faintly tinged with green or blue. The fact that smoky quartz is sometimes called smoky or false topaz by jewelers is doubtless responsible for some surprising reports of the last year or two. Accounts have been given of huge masses of wonderful "topaz" crystals in Auburn, and we have been told of the picking up of "topaz" so often and in so many places, that it would seem that Maine must be chiefly a ledge of this mineral.

Another Stoneham mineral is beryllonite, which is found at no other locality in the world. This is a transparent beryllium mineral, and if its hardness (which is but little more than 5) were greater, it would furnish brilliant, colorless gems. A peculiarity of the crystals is the opalescence sometimes produced on the surface by the presence of minute cavities.

Besides the smoky variety, other beautiful quartz occurs. Paris, near Mount Mica, has yielded the finest rose quartz ever known; and amethyst, which is a purple quartz, has been found at Stow in crystals of rare fineness of color. Few of these crystals have been sufficiently clear to cut gems. Garnets are occasionally picked up in transparent gem crystals, splendid cabinet specimens of cinnamon garnet being found at Raymond and Phippsburg. Green garnets have been found in fair crystals at Hebron and West Minot, but not in gem quality. The blue sodalite of Litchfield, it has been suggested, might supply handsome ornaments or low grade gems, although this, like other showy stones mentioned, is deficient in hardness.

An interesting possibility, though not one to justify expensive search, is that two or three of the Maine minerals, now known only in specimens of comparatively little value, may some day, through fortunate accident, be discovered in crystals that will supply gems of importance. The rare emerald already mentioned is one of these. Another is spodumene, which is fairly abundant at Paris, Windham, and other places, and which, in transparent green crystals, now known only from North Carolina, is a gem prized scarcely less than the emerald. Hiddenite, as this green spodumene is called, is, indeed, already given in the list of Mount Mica minerals, although it does not appear that the specimens were worthy of mention as true examples of this variety. A third possible rare gem is chrysoberyl. This is not taken out as a gem stone in North America, and if it is ever so found, there are reasons for believing that it will be at a Maine locality. Opaque crystals are now known from Greenwood and other places. Gems of beautiful yellow chrysoberyl—the true cat's eye—come from Ceylon and Brazil, and are highly prized. A Siberian variety, known as alexandrite, has the unique property of appearing emerald-green by daylight and columbine-red by artificial light.

A notice posted in the office of a hotel directing guests to leave their "valuables" in the hotel vaults does not apply to mineral specimens in a guest's trunk.—Brown Hotel Company vs. Burckhardt (56 Pacific Reporter, 188); Court of Appeals of Colorado.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

The Railways of Uruguay.—The railway system of Uruguay is well planned for the service of the state, and as the state has been and is yet the guarantor of interest—at one time at the rate of 5 per cent., but now 3½ per cent.—on a value of $24,432 per kilometer (0·621376 mile) on the bonds outstanding, there was no reason why the public convenience should not have been considered in every way, says United States Consul Albert W. Swalm, of Montevideo.

The railways number 12, the mileage is 2,177, and the capital invested is $93,971,179.

The amount paid in 1897 by the government of Uruguay, on its guaranty of interest on bonds, was over $1,000,000 (Uruguay standard being $1.0352 United States) and a regular percentage of all custom house receipts is set aside for the fund thus used. The official returns do not show that a single line has yet proved self-supporting above the guaranty of interest by the government, nor is the outlook very promising.

All the fuel for the motive power is imported from Wales, and the machinery of all kinds, rails, chairs, and general outfittings, comes from England. A good percentage of capital will never go back to England, for the simple reason that the earning capacity of most of the lines can, under no present conceivable circumstances, be brought to the point desirable for all such enterprises. The interior of the country is largely devoted to cattle and sheep farming, and the season for handling these is not continuous. The cultivation of grain, while it is showing a slow increase and has added a considerable item to the receipts for freight, is not of such promise as to give the management much encouragement.

The construction of the lines can be classed from excellent to first-class, and the best of English methods—somewhat conservative, yet safe—have been employed. The bridges and culverts can hardly be improved upon for lines with such traffic. The grades are generally easy, and, with but few exceptions, are kept to a legitimate normal. The rolling stock is good, but it does not compare in any way with the equipment on similar lines in the United States. On none of the lines at present is a through passenger train operated; the trains are all mixed, that is to say, freight and passenger in the same train—the old accommodation train of the Western roads.

The management is to be commended for the practical results obtained. The rates maintained would be deemed very high in comparison with the American standard, but they are not more so than is required by the investment and by public convenience.

It should be stated that some of the passenger equipment is of American manufacture (Hollingsworth), and it gives the best of service and satisfaction. One cannot well fail to appreciate the scrupulous cleanliness that marks the care of the passenger equipment at all times.

The general station at Montevideo is the most modern and complete in South America. Its construction is very substantial and its style of architecture at once elegant and dignified. The offices are roomy, and the central management of all departments are found in the spacious building. In its general arrangements it deserves to rank with first-class stations in our larger cities, and would be deemed a great credit to any railway company in the United States.

The width of the station is 86 meters (282·15 feet) and it has two stories of 10 meters (32·8 feet) each, the first leading out to a handsome terrace over the principal entrance, resting on groups of pillars, forming three arches. These arches run all along the base over the several entrances to the station and are each 7 meters (22·8 feet) wide by 9 meters (28 feet) in height. The lower interior contains ample waiting rooms for passengers of all classes, including the usual accommodations of restaurant and toilet rooms for both sexes. The depth of the station is 225 meters (738·2 feet), and it is handsomely spanned by an iron roof with glass. The cost of the total improvement, including sheds, lands, etc., all included in the station grounds, was £2,000,000 ($9,733,000), the station proper costing $600,000 in Uruguayan coin. One of the imposing sights, not only of the station but of the city, is the stairway of Italian marble leading to the second floor. It is lighted by electricity, with 750 incandescent sixteen candle power lamps and twelve 2,000 candle power arc lamps fed from an independent station. The offices are also heated by electric appliances.

The side wings of the building are 120 meters (394 feet) in length and 10 meters (32·8 feet) high. The glass roof, covering four platforms and seven lines of rails, is 120 meters (394 feet) long by 48 meters (157½ feet) wide. Two of the platforms are extended 100 meters (328 feet) outside the body of the station to meet the requirements of very long trains. The arrival lines are provided with hydraulic buffer stops supplied by a London firm.

The offices of the local committee, administration, etc., are on the first story, and are the best and most comfortable in the republic.

The clocks are electrical, being worked by a regulation clock, which makes a contact every half minute, moving all the others simultaneously.

The station has a complete telephone installation, with exchange board, enabling any two offices to communicate and also permitting connection with the subscribers of the city lines.

The foundation stone was laid August, 1893, and the station was opened to the public service July 15, 1897.

The mechanical staff, heads of departments, engine men, and machine shop chiefs are almost exclusively European (English and Scotch predominating); but many young men native to the country are working into positions of responsibility. Station masters, as a rule, are natives, but in all larger stations Englishmen and native assistants are found. A very thorough and constant inspection is kept up, and great care is shown in the operating department, an accident or derailment being rare.

Windows and Doors in Marseilles.—A series of questions having been put to me concerning the possibility of introducing factory-made window sashes and doors in France, I wish, says United States Consul Skinner of Marseilles, to say first that the method of interior construction in this country does not resemble our own, and any manufacturer desiring to do business here should visit the country and study the local peculiarities. All building is done to stay, and the light pine doors and sashes often used in America would not do here at all. Furthermore, there are no window frames in France that slide up and down as they do in the United States. The sashes are as long as doors, a double sash being made for each window, opening inward, clamped with a special fastening, and provided with interior and exterior blinds. In this southern country, where winds are severe, the outside shutters have immovable slats and are very heavy. Taking up the questions in detail, I have to say:

There is no existing demand for factory-made doors. The notion prevails that ready-made doors are inferior to the hand-made article, and a demand would have to be created.

As to shapes and styles in use, they are many. Sliding doors are unusual. As a rule, even large double doors swing on hinges. The dimensions of single doors of the ordinary type are: Height, 2·20 to 2·25 meters (7·22 to 7·38 feet); width, 80 to 90 centimeters (2·6 to 2·8 feet); thickness, 3½ centimeters (1·4 inches). Doors generally are hung on simple hinges. As no factory-made doors are sold, prices cannot be quoted. For hand-made doors of the ordinary variety, the ruling price is 7 francs ($1.35) per square meter (10·76 square feet), or for double doors, 10 francs ($1.93) per square meter.

One builder ventures to say that from three to five thousand doors are used annually in Marseilles. No dependence can be placed on the guess. The consumption obviously depends on the amount of building.

Doors used here are of local manufacture, the lumber generally coming from Sweden or Norway. There are no special door factories in this city.

I have no suggestions to make as to packing for exportation. No doors are imported.

The questions relating to sashes are nearly all answered by the foregoing.

Shoes in China.—The following is a summary of information contained in a letter (dated April 21, 1899) from Consul-General Goodnow, of Shanghai, to a Massachusetts board of trade, and in a letter to a Texas firm from Mr. Barchet, the interpreter of the consulate-general in Shanghai, forwarded by Mr. Goodnow under date of April 19:

There are no American-made men's shoes for sale here. A good line of shoes would find a market among the foreigners in China. Most of the foreign shoe dealers, however, being English, naturally prefer to handle English goods, and men's shoes come chiefly from that country. Foreign articles sell at $14 Mexican ($6.60 gold).*

All foreign clothing, including shoes, can be imported free into Shanghai and to other open ports in China, but when such goods are transshipped into the interior, they are subject to a duty of 2½ per cent. ad valorem.

American boots and shoes are preferred by most foreigners in China; but before beginning business here, it may be well to take into consideration the number of people who would be likely to buy, and the present condition of trade.

The foreign population of Shanghai is in the neighborhood of 5,000, and the total number of foreigners all over China (including Hongkong, which is British) probably does not exceed 15,000. To meet their wants, shoes have hitherto been imported in small consignments from England, Germany, and the United States. There are also a number of native and Japanese shoemakers, who make shoes to order at reasonable prices: Ladies' shoes, at $4 Mexican ($1.88 in the United States currency); men's shoes, from $4.50 to $6 Mexican ($2.12 to $2.83). These prices include patent-leather shoes, which are hand sewed and comfortable as a rule, though in style they do not compare with the American shoe. Patent leather is popular. American and Japanese leather is used for the shoes made in Shanghai.

As to the banking facilities, Shanghai has connections with all parts of the civilized world, and the Hongkong and Shanghai Banking Corporation has agencies in San Francisco as well as in New York city, which will be found reliable and accommodating.

The shoes which natives wear—peculiar to China—are made of cloth or leather. Their cloth boots and shoes have soles half an inch to one inch in thickness, which are made of rags and paper firmly stitched together; these can be bought from 25 cents (gold) upward.

Native leather boots and shoes shod with heavy iron nails are worn in wet weather; they are worth 50 cents to $1 (gold) per pair.

If there can be put on the market here shoes as good in quality as those the Chinese make, at a lower price, an unlimited field is open to enterprise. It would hardly be worth while to have circulars, etc., translated.

* Taking the value of the Mexican peso on April 1, 1899, as estimated by the United States Director of the Mint, as 47·2 cents.

American Shoes in Germany.—The efforts made by Mr. Mason and other consuls to get American manufacturers of shoes to introduce their wares into this empire are bearing fruit, says U. S. Consul J. C. Monoghan, of Chemnitz. They are, however, as was to be expected, meeting with opposition. How true this is will appear from the following translation of an article concerning the importation of shoes from the United States:

"According to official publications in America, it appears that the exports of American shoes to Germany are increasing. . . . The letters of two German business men handling such shoes prove how little German firms care to protect German shoemakers. It looks as if an understanding among interested parties should be arrived at before Germany is flooded with American shoes. It is recommended that shoemakers' guilds in the large cities make manufacturers and people aware of the efforts to introduce American shoes into the empire, and point out the losses to the shoe industry and to the buying public that must grow out of such sales. It would not only be a useful thing to specify the bad qualities of American shoes in the technical daily papers, but to advise the local unions, the manufacturers, merchants, etc., to procure samples of American shoes, show the quality of same by separating the leather from the paper, and examine the soles sewed on in long stitches with binder's twine. The results should then be published in the papers and put before customers. According to the opinion of Germans living in America, the durability of American shoes is at best no more than one-fourth or one-third that of Germany's well made ones. But the elegance of American shoes, even the low-priced grades (Schlendersorten)—and these, because of their cheapness, are the only ones worth considering in Germany—make them favorites with loafers. The working people are not satisfied with them. German-American shoe merchants in Washington admit that American shoes are of much poorer quality than the German; but their finish and apparent fineness make business lively."

If a word were wanted to prove the oft-repeated statements of consuls, that Germans will endeavor to "knock out" any goods that we may send here just as soon as these begin to secure success, it is spoken in the above extract. This epitomizes what has appeared day after day in the empire's public press ever since propaganda for American shoes began. It goes to show what our merchants and manufacturers will have to contend with in their work to make sales in Saxony or any other part of Germany.

What are the facts? Hundreds of Germans who visit the United States "load up" with American shoes before they return. A shoemaker in this city, to whom a pair of American shoes was given to be mended, took them apart to study the workmanship, made a last from them, and is now using them as a model. One of my acquaintances, seeing the superior workmanship, elegance, etc., of some shoes sent me from the other side, ordered fourteen pairs for himself, family, and friends. Between American shoes and those made in this empire there is actually no comparison. One pair of ours will outwear two pairs of German make; at least, that has been my experience. Every effort is being made to make our shoes unpopular in this market. Some of these efforts—the foregoing article, for instance—seem unfair. Our shoes are notoriously the best offered anywhere for the price. I have seen shoes bought in Boston for $3 (12.60 marks) a pair outlast—keeping an elegant appearance all the time—two pairs bought here for 22 marks ($5.24) a pair.

I bought for my boy the other day a pair of brown or tan leather shoes of German make. The little fellow walked in them from the kindergarten home, less than a quarter of a mile, in a shower; when he got home his feet were wet, because the water had gone through sole and upper. When I remonstrated with the merchant for selling me such shoes, he said, "They were intended only for fair weather."

If imitation is the sincerest flattery, American shoe manufacturers should be satisfied, for their forms, styles, etc., are being imitated here; how successfully, I cannot say. Goodyear's welt is advertised in a great many shoe windows. Shoes like the Emerson, Douglas, Regal, etc., should sell in every city of this empire.

There is a good market here for American shoes. Just how it should be worked must be left to merchants themselves. All that consuls can do is to point out the possibilities of creating one. If every city of the empire had one or more stores offering good, solid, sensible American shoes at practically the same prices for which they are sold at home, I am sure thousands would sell where now only dozens are sold. Nor is the exploitation of this market the only thing to be considered. If our manufacturers can sell here, they can sell in markets hitherto held by the Germans. The great gain is not a market here, for, after all, so successfully do Germans imitate that this market cannot be held long against the efforts that will be made to dislodge us. The advantage will be in winning markets in South America, the East, South Africa, and Australia, and in maintaining a practical monopoly of the market at home.

Care must be taken to send only the very best goods that can be sold at the prices that prevail here. These run from 75 cents to $6 for good shoes. In no country on earth is so much done to induce people to patronize home products as in this empire; but commerce in shoes, as in all things else, is outside of patriotism, and articles like the one quoted will be powerless against any well formed and well conducted effort to give better shoes for less money to the German people than they now receive. The thing to do, it seems to me, is for American manufacturers to pool their issues, and send experts to examine this market. Another excellent idea would be to exhibit at Paris next year as extensively as possible. It may not be out of place to say that there is a field here for certain American leathers—sole leathers in particular. Nothing in the sole line made in this country, as far as I can see, is as tough and durable as ours.

New Gold Mines in Mexico.—Vice-Consul Taylor writes from Ensenada, May 20, 1899, in regard to the discovery of very rich gold placers near the San José and Santa Clara Mountains, within a league of the Pacific coast. The port is Ascension Bay. There are already, says Mr. Taylor, about 2,000 persons on the ground. The mining camps of Santa Rosalie, San Iawa, and Calmallé are deserted. The placers are 3 leagues wide and 12 or 15 leagues long.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

ENGINEERING NOTES.

The Eiffel Tower is undergoing a complete renovation in preparation for the forthcoming exposition. The entire structure will be painted with an enamel in five shades. The dome and summit are to be of a fine lemon chrome, and the shades will graduate to the pedestal, which will be a rich, dark orange. The Mechanical Engineer states that for the two coats which are to be applied upon the tower, nearly fifty tons of enamel will be employed.

The "long bridge" across the Potomac at Washington, D. C., is soon to be torn down to give place to a modern steel structure to be erected by the Pennsylvania Railroad. As a historical structure this bridge is perhaps one of the best known in this country. During the civil war it was considered the connecting link between the North and the South, and was crossed by thousands of troops. The bridge was built in 1833 and has been many times repaired.

As showing the much greater weights hauled on American railways than in England, the following report of a coal train recently run on the Baltimore and Ohio Railroad, a distance of 100 miles, is of interest. It consisted of 50 Schoen steel cars of 50 tons capacity, each car weighing 15 tons empty, and carrying an average load of 44 tons of coal. This train was hauled by a consolidation engine, with cylinders 22 inch by 28 inch, and driving wheels 54 inches in diameter. The total weight of the train was as follows: Cars, 760 tons; coal, 2,188 tons; engine, 70 tons; tender, 35 tons; total, 3,050 tons; percentage of coal to total, 71·0 per cent.—Practical Engineer.

"In our news columns during the month of May we noted orders for 4,872 cars," says The Railway Gazette. "Of these, 2,035 were coal, ore and gondola cars; 2,056 were box, stock and refrigerator cars; 500 were flat cars; 140 were steel cars, and 141 were passenger and street railroad cars. Orders were also noted for 122 locomotives, 31 of which were for foreign roads, and of the total of 122, 22 were for passenger, 82 for freight, and 18 for switching service. This shows a further heavy falling off in orders in the April record, and compared with the month of March, when orders were noted for 21,667 cars and 541 locomotives, the reduction is remarkable. As the weeks go by, and the builders have a chance to catch up with their orders, it would seem that early deliveries must be easier to obtain; but the crops are by no means safe yet, and there is much uncertainty about them. Several roads are holding back orders on account of the high prices now asked for rolling stock by the builders."

Within the next few weeks the Navy Department proposes to have plans completed, and to issue a call for bids to construct a large new masonry dry dock at the Portsmouth navy yard, and a timber dock at League Island. Borings have been completed for the Portsmouth dock, and a most suitable foundation has been discovered of a hard, rocky nature, which will obviate the necessity of using concrete to any extent in forming the bottom and side walls. This dock will be equal in capacity to that building at the Boston yard, but will differ in some respects as to the dimensions at the top and bottom. While there has been considerable opposition to placing a dock at this yard, owing to the narrow channel approaching it from the sea, it is not thought that this defect will seriously operate against the entrance of the largest warships if carefully handled. The construction of an immense dock there will necessarily result in a revival of activity at this station, which has been for a number of years practically idle, except for small class of work. The League Island dock will be of the timber variety, and almost on similar lines to that for which bids were opened this week, to be located at Mare Island. These three docks, with that at Boston, will give the navy important docking facilities at all the leading ports, both on the Atlantic and the Pacific.—Army and Navy Journal.

Among the important works recently undertaken by the Department of Railways and Canals in Canada are a couple of hydraulic lifts on the Trent Canal at Peterborough, Ontario. The dimensions of these lifts are much greater than those previously constructed at La Louviere, Les Fontinettes, or Anderton. The vertical traverse of the new lifts is to be 65 feet, and the tanks will measure 139 feet long by 33 feet wide, and be 8 feet deep over the sills. The two tanks act as mutual counterbalances, the hydraulic presses under each being in communication. When one lift is at the top of its stroke, the other is at the bottom. Under these conditions the arrangement is such that on both tanks being opened to their respective branches of the canal, the water in the upper tank is deeper than that in the lower. Hence, if the gates are closed and the valves on the pipe communicating with the two hydraulic cylinders opened, the upper tank containing the greater depth of water will descend, raising its fellow in the process. At the end of the stroke the tanks are locked in position, and when the gates or sluices are opened, water will flow from the lower tank into the lower branch of the canal, and from the upper branch of the canal into the upper tank, thus establishing a fresh surcharge, enabling another stroke to be made when necessary. Each tank with its contents weighs about 1,800 tons, and is carried on a hollow cast iron ram 7½ feet in diameter. The hydraulic cylinders are built up of rings of steel castings 3½ inches thick, bolted together by external flanges. To supply unavoidable leakages from the presses, an accumulator is provided, which is supplied by pumps driven by turbines operated by water taken from the upper reaches of the canal. This accumulator also supplies the hydraulic plant with which the gates closing the tank and the branches of the canal are worked, as well as a number of hydraulic capstans by which the craft passing the lift are handled. The joint between the ends of the tank and of the canal branches, above or below, is made by means of a collapsible air-tube, which, when charged with air at 30 pounds pressure, makes a watertight joint between the opposing faces. The whole plant is intended to be operated by three men, two of whom attend to the gates on the up and down stream sides respectively, while the third has charge of the lift proper. The engineer of the work is Mr. R. B. Rogers, M. Can. Soc. C. E., while the Dominion Bridge Company, Limited, of Montreal, are the contractors.—Engineering.

ELECTRICAL NOTES.

The installation of the new magnetic departments of the Parc St. Maur Observatory has just been completed by M. Moureaux.

It is stated that the Emperor William has ordered an electric motor boat from the Imperial Dockyard at Kiel, to be ready for the regatta there this year.

An electric clock, said to be one of the largest in the world, has recently been erected at the Liverpool Street Station of the Great Eastern Railway. It is constructed of iron and manganese steel, and the case itself forms a room inside 9 feet square. From the pinnacle to extreme ornamentation at base is 21 feet. The four opal dials with bold Roman figures, facing the four points of the station, are 6 feet in diameter. The figures of each hour are about 18 inches apart. This clock will be worked by a regulator clock fixed in the main telegraph office.

The Municipal Council of Moscow have decided to extend their tramways and to replace all their present ones with an electric system. When the scheme is completed there will be eighty-three miles of electric tramway in the town. In general the overhead system will be employed, but on some sections accumulators or surface contacts are imposed. In the center of the town the cars will run with a three minutes' headway, and they will be electrically heated and lighted. Four years is allowed for the execution of the work, and the estimated cost is two and a half to three millions of pounds.

In a paper read before the recent annual meeting of the American Society of Mechanical Engineers, Mr. William H. Bryan gives some interesting figures as to the cost of boilers, engines, dynamos, etc., for a modern commercial building, consisting of three 125 horse power engines and three 75-kilowatt dynamos. The cost of the water tube boiler plant was $13.97 per rated horse power; ordinary boilers would have cost $11.44 per horse power. Compound engines with foundations cost $11.38 per rated horse power; dynamos and switchboard, $22.80 per rated kilowatt capacity; wiring, lamps, fans and motors, per kilowatt of dynamo capacity, $42.10, or $83.90, including lighting dynamo and engines.—American Electrician.

An interesting shipment was made recently of what is said to be the first electric car of the American open summer type ever sent to Europe. The car, which was made in Philadelphia for a French tramway company, is of the standard 12-bench type. The length of the body is 34 feet. It is 43 feet 8 inches over the buffers. The limitations of French streets, however, come in, and a breadth of only 5 feet 10½ inches is permitted at the sills, and the extreme width at any part had to be kept down to 7 feet 8¾ inches. For this reason, although the car has 12 benches, its seating capacity will not exceed forty-eight persons, allowing the American standard of 17 inches each. The openings between the seats are closed by leather-covered hook chains. The interior finish is of bird's eye maple for the head lining and ash for the trimming over the openings. These cars without motors weigh 15,275 pounds. The weight of one of the trucks was 3,000 pounds. The great length of the car is particularly noticeable, showing that the French street railway people at least are now alive to the advantages of as large a car as can be used on their streets.

The electric furnace is used in glass manufacture by a process invented by Kroll, of Cologne. From a description in L'Electricien the following is abstracted by The Electrical Review: "It is said that excellent results have been obtained. An economy of as much as 60 per cent. in coal is claimed, and it is said that the electric furnace heats the ingredients contained in the glass crucible without danger of spoiling the products with particles of coal and cinders. At the same time the heat required for melting the same quantity of glass is much less when it is generated within the crucible itself than when it is applied externally, and the men engaged around the furnace can approach the mass of melted glass without danger of being burned. It is said that a mass of glass requiring 30 hours to melt in the ordinary furnace can be reduced to the liquid state in 15 minutes by the electric furnace. On this account the large pots used in ordinary glass furnaces are unnecessary, and small crucibles of carbon, containing from 40 to 50 pounds of raw materials of glass, are found to be quite satisfactory. Another point of importance is that the work can be commenced or stopped at any time without serious loss, and work on nights, Sundays, etc., is thus rendered unnecessary."

L'Electricien gives a very animated description of a barber shop in which most of the familiar operations are conducted by electricity. For example, hot water is obtained by passing the stream of a hydrant through a German silver tube in a soapstone case, the tube being electrically heated, so that the water is nearly boiling when it passes out at the spigot. "For the crimping of the frizzes of our young ladies there is no longer necessity for recourse to the hot iron. For a long time the defects of this method of heating have been noticed, for the capillary artist sometimes forgets and leaves the iron in the heating apparatus too long, so that when it is used with blond or brown hair, if it does not make a burn, it makes the hair red, which is even more disastrous." The new curling irons heat themselves. In the interior of the rods is a ferronickel wire, which can be brought up to the proper temperature and will then remain at this same temperature indefinitely. But it is in the cutting of the hair that electricity has produced the most complete revolution. The scissors have slowly given way to clipping machines, and these, in their turn, must disappear before an electrically heated platinum wire, with which the hair may be burned off. The apparatus as described consists of a metallic comb, along one side of which is stretched the hot wire, and as this is passed through the hair, the red hot wire burns it off neatly and smoothly, and at the same time seals up the ends of the hair; it being supposed in this way to produce a very desirable effect. The method is, of course, entirely antiseptic, but it hardly seems likely that the air of a barber shop will be very pleasant when these new methods attain a wide popularity.—American Electrician.

MISCELLANEOUS NOTES.

While any step toward disarmament in Europe is improbable at this time, a powerful presentation might be made at The Hague of the financial side of the case, says The St. Louis Globe-Democrat. Most of the nations of Europe are adding largely to their public debts, and disarmament for some of them may become a necessity. Annual deficits are quite the usual thing throughout the Continent. France runs behind annually about $100,000,000; Austria, $80,000,000; Russia, $50,000,000; and Italy, $30,000,000. Minor nations, like Spain, Turkey, Portugal, and Greece, are not many removes from bankruptcy.

Speaking of America's advantages, the Portland Oregonian observes that whatever may have been the conditions of a past time, the future will know few distinctions between the great manufacturing countries of England, the United States, and Germany in engineering and mechanical skill. From this time on whatever one has all will have. Differences hereafter will relate to men rather than to devices. Whichever of the three countries named shall develop the most intelligent, persistent, and reliable body of workmen will have the advantage and will gain vast benefits by it. To-day this advantage is with America, and there ought to be in the engineering and manufacturing system of the country enough discretion to maintain it.

The production of petroleum during April, as represented by pipe-line receipts, amounted to 4,017,346 barrels, 2,618,249 barrels being of the Pennsylvania grade and 1,399,097 barrels of the Ohio quality, according to The Oil, Paint, and Drug Reporter. The total shows a decrease of 130,068 barrels as compared with that of March. The decrease in the Pennsylvania product was 31,279 barrels and in the Ohio product 98,789 barrels. The total deliveries were 4,175,296 barrels, 2,377,486 barrels being Pennsylvania oil and 1,797,810 barrels Ohio oil. The decrease amounted to 313,874 barrels. The decrease in the deliveries of Pennsylvania oil amounted to 257,959 barrels and in Ohio oil to 55,915 barrels. The total stocks at the close of the month amounted to 25,772,355 barrels, 12,047,444 barrels of which was Pennsylvania oil and 13,724,911 barrels Ohio oil. The reduction during the month was 160,572 barrels. The stock of Ohio oil was reduced to the extent of 401,135 barrels, while that of Pennsylvania oil showed an increase of 240,563 barrels.

Prof. W. H. Holmes, one of the head curators of the National Museum, has returned from a trip to Mexico under the auspices of the Smithsonian Institution. He accomplished the exploration of the ruined city of Xochicalco, "Hill of the Flowers," something not done hitherto in a scientific and thorough way. The hill is a series of stone-faced terraces from base to the summit. It is a network of walls, finished in selected or cut stone and well plastered. The summit is about one-fourth of a mile square, and in the center stands a temple of simple but artistic character. Its walls are covered with rude glyphs carved into them. The temple is about 60 by 80 feet square and is surrounded by a very complete system of courts and pyramids. Prof. Holmes says the city belongs to the pre-Spanish period, and that to remodel and build the summit in the extensive way now indicated must have taken centuries of time. Therefore he concludes that the city is much more than five hundred years old, as there is no record of its capture and occupancy by the Spaniards.—Washington Star.

A great corn exhibit is to be made in the Paris Exposition of 1900, says The St. Louis Globe-Democrat. It is proposed, indeed, to make this one of the most interesting of all the American displays at that fair. The object, of course, is to popularize this great American product throughout the world. Thus far the outside world has been strangely shy of Indian corn. It has more nutriment than rye and barley, which are much more widely used in Europe than corn. This propaganda has a great interest for Americans. Practically all of the product which is raised in the world is raised on this side of the Atlantic. It is the most valuable of all the crops grown in the United States. The endeavor to open new markets for Indian corn by the exhibits at the Paris Exposition next year will undoubtedly be successful. In fact, corn is conquering new markets already, although not to the extent which its merits as a food crop demand. In 1894 the corn exportation of the United States was $66,000,000. It was $28,000,000 in 1895, $101,000,000 in 1896, $178,000,000 in 1897, and $212,000,000 in 1898. This gain is encouraging. It should be kept up. There is a chance that it can be largely increased if the propaganda which has been started for its general introduction throughout the old world is prosecuted intelligently and persistently. The corn feature of the Paris Exposition will be watched with great interest in this country.

Figures compiled by a firm of sugar brokers, says Bradstreet's, and published by them in their weekly circular, afford some idea of the magnitude of the beet-sugar industry in this country. Subjoined are the figures, and they are intended as estimates of beet-sugar output in the States mentioned during the coming season:

	Sowings. Acres.	Beets. Tons.	Sugar. Tons.
New York	3,200	32,000	3,200
Illinois	4,000	34,000	3,400
Michigan	43,400	320,000	32,000
Minnesota	4,000	36,000	3,600
Nebraska	10,500	92,000	9,200
New Mexico	2,500	20,000	2,000
Colorado	3,800	30,000	3,000
Utah	7,800	78,000	7,800
Oregon	2,000	18,000	1,800
Washington	2,200	20,000	2,000
California	60,700	540,000	54,000
Total	144,100	1,220,000	122,000

The ton in the above statement is the long one—2,240 pounds. In making up the estimates, allowance was made for loss in extracting the sugar from the beef because of inexperience. Last year all the beet-sugar factories in the country produced 33,960 tons, so that when one compares the estimate given in the foregoing, one can obtain an excellent idea of the industry in one year.

THE NEW DAIMLER MOTOR-CARRIAGE.

DURING the last few years there have appeared in the streets of our great cities heavy wagons and luxuriant carriages driven by motors. The public, at first, looked upon these new vehicles with distrust. The noise of the driving-gear, and of the exhaust, which has earned for these vehicles the name of "teuf-teuf" in Paris, as well as the disagreeable smell of the exhausted gases, were at first the source of no little annoyance. In time these defects were overcome by the constructive progress which had been made, and by the experience gained in the manufacture of bicycles. Now we can say that the automobile has taken its place in our daily life, and that its importance is increasing. The new motor carriage industry owes its origin largely to G. Daimler, of Cannstatt, who, as early as 1885, produced his perfected motor.

The Daimler motor, although a German invention, received scant attention in its native country; it was, however, eagerly taken up in France and developed. In that country and in England, automobile clubs have been established for the purpose of bringing the motor-carriage more widely into use. Within recent years there has been established in Berlin "Der Mitteleuropäische Motorwagenverein," which has given exhibitions of automobiles, and has awarded prizes to the winners of motor-carriage races.

Although automobiles are seen often enough in our streets, it will require no little time before they will supplant the horse. So accustomed are we to the use of the horse, that we do not fully recognize how dependent we are upon him. Few of us seem to recognize that the horse completely dominates city life; that to him is due much of the uncleanliness of our streets; that he is responsible for much of the noise which accompanies city traffic.

The horse requires a rough pavement in order that he may not slip. His soft hoof, by nature intended for turf, we have clad with an iron shoe, the calks of which enable him to obtain a firm foot-hold. Smooth pavements can be used only on very level streets.

If, for the horse, we could substitute the motor, all streets could be paved smoothly and the tires of all wheels could be made of resilient material. All noise would cease; and the repairing of roads would hardly be necessary.

The development of the motor-wagon is intimately connected with development of a suitable motor. There have been used, with considerable success, steam, gas, and petroleum engines, and electric motors driven by accumulators. The steam engine has proved its effectiveness in the Serpollet carriage, and is especially serviceable in long-distance traveling. The good qualities of the steam engine, its adaptability to all conditions and its economy, have been fully recognized; but the indispensable boiler renders the construction somewhat complex; for which reason the hydrocarbon motor is more widely used. Of these hydrocarbon motors, it is our purpose to describe that made by the Daimler company.

The Daimler motor is made either with one or two cylinders, from one-half to twenty-five horse power. The cylinder-piston is provided with a valve to control the admission of the explosive mixtures. In the upper end of the cylinder above the piston (in the vertical type of engine) the explosion chamber is located, to which the inlet and exhaust valves are connected. Every other stroke of the piston is a working stroke.

The speed of the motor is controlled by a governor which operates to cut off the combustible gas whenever the speed becomes excessive. The explosion chamber is incased in a water jacket. The motive agent in stationary motors is illuminating gas, in portable engines, benzine, benzoline, or petroleum. The amount of motive agent required per horse power varies from 0·36 to 0·45 kilogramme per hour.

In automobiles the power is imparted to the transverse shaft by means of belts running over tightening pulleys. By providing pulleys of different sizes the speed may be varied. The water-tank containing the cooling water is supplemented by a second tank between the steps of the carriage, which tank also acts as a foot-warmer in winter. The method of continuous water-cooling employed consists in directing the heated water into the annular channel of a wheel similar to the water channel used for friction brake dynamometers, in which the warm water is whirled at the speed of the engine fly-wheel, and is taken back continuously by a tubular off-take. The whirling and consequent evaporation effect a considerable cooling of the water contained in the jacket.

In the accompanying illustration a closed victoria is represented, which is fitted with a motor of the type described. Carriages of this kind appeared as early as 1885, but since that time the progress which has been made has considerably increased the efficiency of the motor and beauty of the carriage. These automobile victorias are fitted with benzine motors of two to six horse power, and are built to hold from two to six persons. The motor is mounted in the wagon-frame and is supported upon elastic arms, so that its vibrations shall not be communicated to the wagon-body. The front axle is centrally pivoted, and can be turned by means of a hand-lever and connecting links. The wheels are provided either with solid rubber or with pneumatic tires.

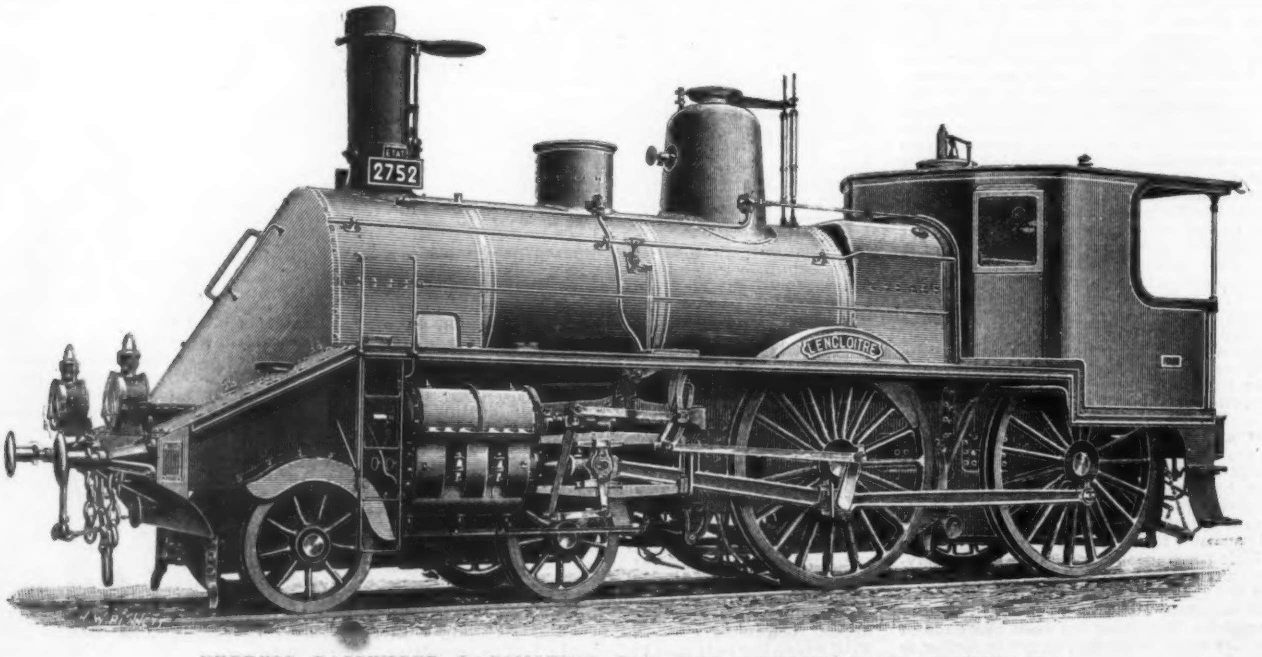
For our engraving we are indebted to Glaser's Annalen.

A CLOSED VICTORIA.

EXPRESS PASSENGER LOCOMOTIVE FOR THE FRENCH STATE RAILWAYS.

WE illustrate an express passenger locomotive constructed by Messrs. Schneider & Company, of Creusot, for the State railways of France. The engine has four coupled wheels and a four-wheeled front truck; the cylinders are placed outside the deep plate frames, which are extended well forward of the truck, and beveled at the end to receive the sharp bow plate covering of the smokebox door, a device introduced to reduce the air resistance when running at high speeds. With the same object the front of the driver's cab is finished with a pointed curve, as will be seen by reference to the general elevation on this page.

The construction of the truck is so arranged that the center pin on which it turns allows a lateral movement on each side of the center line of an inch, the motion being controlled by plate springs. The boiler and outside firebox shell are of extra mild steel plates, and the tubes are of steel on the Serve system. The firebox and the front tube-plate are of copper. The firebox is of the Belpaire type and is placed between the driving wheels, so that a considerable depth is available; it is fitted with a brick arch. The boiler is fitted with three safety valves, two of which are on the dome, and the third over the firebox. The boiler is fed by two 9·5 millimeter Friedmann injectors placed at the back of the firebox. The exhaust is of the variable type, and can be controlled from the driver's footplate. Steam admission to the cylinders is regulated by Walschaert's gear. The valves are cylindrical; an air entrance valve is placed on each steam admission pipe to allow the entrance of air during admission, when the engine works with a closed regulator. The reversing gear is operated by a quick motion screw. This engine and the others built on the same patterns are provided with a Wenger compressed air-brake, of the model prescribed by the French State railways. A continuous acting Bourdon lubricator is adapted to the slide valves, and is operated off the link motion.—Engineering.



EXPRESS PASSENGER LOCOMOTIVE FOR THE FRENCH STATE RAILWAYS.

It is reported that the New York Central Road has forbidden the practice of throwing rice, old shoes and similar missiles at newly wedded couples in its railway stations or train sheds. It is claimed that such indiscriminate hurling of things when bridal couples are departing has frequently resulted in accidents to passengers, and the recent measure of the company is taken with the idea of minimizing the chances of such accidents.

THE NORDENFELT RAPID FIRE CAMPAIGN GUN.

GEN. VON GOSSLER, Minister of War, of Germany, has recently made to the commission of the budget of the Reichstadt some assertions as to the respective merits of French and German artillery. As regards the latter, the general has been one of the most optimistic, and this is but natural; for could he do otherwise than proclaim that the new gun that he put into the hands of the German army was the very type of perfection? But it is allowable for a Frenchman to hold a different opinion, and to think that the new French gun is superior to that of the other side of the Vosges.

These two guns, however, have many points of resemblance, and this is due to the fact that both had as a precursor the Nordenfelt gun, which made its appearance as long ago as 1892.

The Société Nordenfelt is a curious organization. It is French and has its headquarters at Paris; its staff of engineers is Swedish; while its manufacturing is done in Belgium, where it uses the shops of the Cockerill establishment at Seraing. Although in a manner international, the Nordenfelt Company, like its associate of Belgium, has proclivities that are at once French and anti-German.

The new German and French rapid fire guns have, as we have just stated, both been suggested by the Nordenfelt; but while France has paid in cash for the privilege of employing certain arrangements, Germany has adjudged itself the right to use the same without opening its purse.

In speaking of the Nordenfelt gun, we shall, by reason of the fact above stated, be giving a description of both the French and German guns. Of the Nordenfelt rapid fire campaign gun, which is of 75 mm. caliber, there are two types, one heavy and the other light, the arrangements of which are alike.

The length of the bore is 24 or 26 calibers, according to the type. The carriage is provided with a hydraulic brake. The charge, powder and projectile, is placed in a metallic shell, like the cartridge of a rifle. The projectile weighs 5 kilogrammes, and its velocity borders upon 500 meters. The piece is capable of firing a dozen shots a minute.

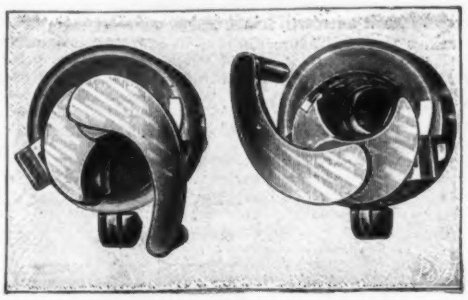


FIG. 1.—BREECH PIECE OF THE NORDENFELT RAPID FIRE GUN.

Beneath the gun there is a vertical trunnion which rests upon a cradle that is capable of sliding upon the carriage whenever a shot is fired.

The recoil is then limited by the hydraulic brake, wheel brakes and an appendage to the trail plate; and the return to battery is afterward effected through a system of springs.

The breech piece consists of a screw, as in ordinary guns; but this screw offers the peculiarity of not pivoting in order to permit of opening or closing the chamber, this operation being effected by revolving the screw 180° in one direction or the other.

After each shot, an extractor removes the shell that remains in the chamber after the projectile has left it. The revolution of the screw in opening the breech suffices to effect the extraction.

The breech piece, which is of a pattern styled "eccentric," is a wonderful piece of mechanism as regards its simplicity and perfect operation. Its invention is due to the collaboration of an officer of the Swedish artillery and one of the engineers of the Nordenfelt company. We believe that the French government paid the sum of 200,000 francs for the privilege of using it in both the army and navy. The German artillery has not adopted it, but continues to use the old style, which doubtless offers much security, but has the disadvantage of being more difficult to maneuver. The Nordenfelt gun may be provided with a shield designed to protect the gunners from the balls of the enemy's infantry.

The carriage of this gun is of very simple construction. The ammunition is placed in boxes made of aluminum and is thus very light. For the above particulars and the illustrations, we are indebted to La Nature.

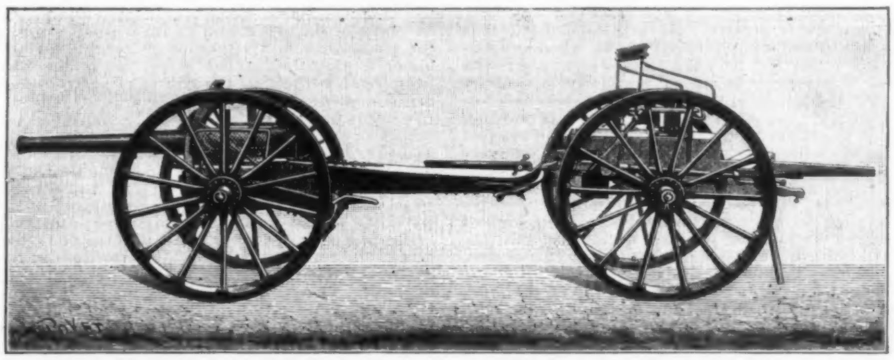


FIG. 2.—LIMBER AND CARRIAGE OF A HEAVY 75-MM. CAMPAIGN GUN.

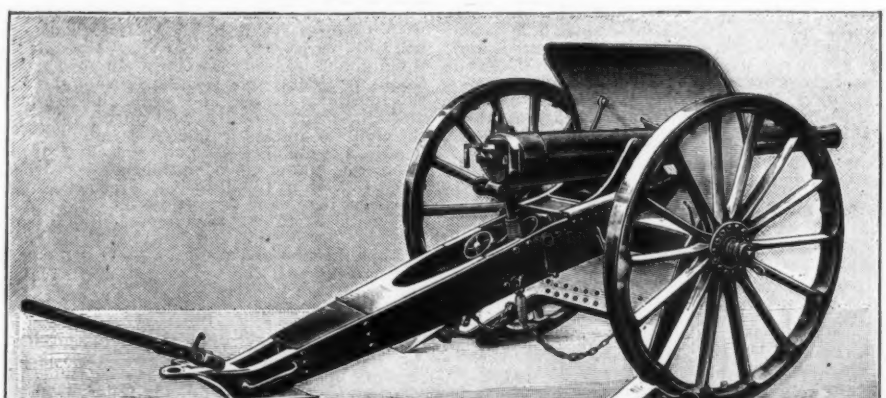


FIG. 3.—NORDENFELT HEAVY 75-MM. CAMPAIGN GUN.

FIG. 4.—NORDENFELT LIGHT 75-MM. CAMPAIGN GUN.

THE PROBLEM OF ELECTROLYSIS.

IT seems probable that within a few years the electric railway companies will be forced to meet a litigation similar in certain respects to the suits brought against them by telephone companies some ten years ago. It will doubtless be recalled by those familiar with the operation of the street railways that, soon after the change from horses to electric traction was made, the patrons of telephone companies became more and more discommoded by imperfect service. The only message received over the wire was not infrequently a buzzing like that from a distant sawmill. It did not take the telephone companies very long to trace the trouble to the return circuits of the electric street railways. The currents wandered away from the tracks and caused the trouble on the telephone circuits, which were of the old-fashioned grounded type. Complaints became so numerous that the telephone companies were forced to adopt some remedy. They were compelled to put up all-wire circuits or the railway companies had to use insulated returns, keeping their electric currents on the legitimate path for them. Very naturally the telephone companies preferred to have the railway companies do the work. The railway companies just as naturally declined, and the result was the important litigation which finally determined that the telephone companies did not have a monopoly of all the earth and the fullness thereof. Since that time they have put up all-wire circuits and also their prices, for they are not engaged in business from philanthropic motives.

It is not more than seven or eight years since the straggling currents from the electric railway were found destructive to a far more important branch of public service than telephones. People conducted business for many years without them, but a water supply has been essential to the well-being of communities for many decades. The situation of a city suddenly deprived of water for a protracted period is inconceivably serious. Power plants would be shut down from lack of water for the boilers, industries would largely come to a standstill, and the inconvenience of the people themselves during the first few days would soon become full of menace to the public health. Hence it is that any danger to a water system is far more important than a similar danger to a telephone system. There seems to be no doubt at the present time in the minds of some of the most conservative managers of waterworks that the responsibility of electric railway companies for the wandering currents from their tracks should be definitely settled in the highest courts. They point out that it is the height of folly to wait for a serious accident before applying the remedy which would have prevented it. It has been shown in these columns time and again that small pipes have been completely wrecked by electrolysis due to the return circuits of electric railways. That in itself is a sufficiently important situation to merit attention, but when it is considered that the same action which destroyed these little services is also slowly ruining the large mains, it is evident that a careful study of the subject should be made.

There is really nothing mysterious about this corrosion of conduits by electric currents. The action is precisely the same as has been employed for many years by electro-platers. If two plates of metal are placed in a material which will conduct a current of electricity, and such a current is sent from one plate to the other, the plate from which the current flows will be gradually eaten away. It makes no difference whether the material is damp earth or the solution used in the vat of the electro-plating apparatus. The only difference between the two cases is that in the former the corrosion is taking place several feet below the surface, out of sight and frequently out of mind, while in the latter case it is under the watchful supervision of a workman. Just so long as electric currents return to the power stations of street railways through the track, there will be danger to the water main. Thorough bonding of the rails, the use of large supplementary return wires and like precautions simply diminish the danger. It is one of the laws of electricity that where a current has two paths by which to reach a certain point, it will divide, part going by one path and part by the other, in direct ratio to their conducting capacity. In the case of a street railway separated by six feet or so of earth from a water main, the return current has two paths back to the power house. One of them is through the rails, the other is through the earth and the water main with the service pipe running from it into the power station. If the earth is dry and the track is well bonded, most of the current will return through the latter, but unless the accepted laws of electricity are false, some current will pass through the earth. In case the track is of the poorly bonded type, still to be seen in many places, then the proportion of current returning through the

earth will be greater. The water pipes, being wholly of metal, are the best of conductors, and if they are in the earth in the vicinity of the track, the current makes for them. If these facts had been understood by city officials, there would not have been so many ridiculous ordinances passed concerning electrolysis. There seemed to be a mania some years ago for a type of ordinance specifying certain classes of bonding in the track, and then requiring all currents to be kept off the water mains, a requirement as absurd as a demand for the companies to make the sun stand still at noon. It was eminently proper to require the companies to send their return currents back to the power house through well bonded track circuits, for that practice diminishes the danger to the pipes, as before stated. To add to that requirement, however, a demand that no electricity should be allowed to escape from such a track system to the pipes was utterly absurd.

It has been shown by a number of engineers that the double trolley system is the only positive remedy for electrolysis. In that system, whether the wires are overhead, as in Cincinnati, or in conduits, as in several cities, the chances for any leakage of current to the ground are infinitesimal. The overhead double trolley is unsightly, and the network of wires is not regarded with favor by fire departments or insurance underwriters. The conduit system is expensive, too expensive for use in many localities. It is evident, therefore, that the problem becomes one of minimizing to the utmost the danger to which water mains are exposed by the present single trolley system of operation. Progressive railway managers have long recognized the fact that if a street car system is built for operation and not sale, it pays to make the return circuit of large conductivity. Some companies have found that a remodeling of their plants in this respect has been equivalent to a large increase in traffic, so great was the previous loss of power from the straying currents. It is hardly likely that enterprising companies will put any obstacles of moment in the way of city officials endeavoring to keep these wandering currents where they belong. Unfortunately, many street railways in this country were built for sale and not for operation. They are poor affairs at the best, and are run on such a small margin of profit that much aid cannot be expected from their managers. These are the companies which render electrolysis so serious, for they will fight every attempt on the part of the city officials to compel them to better their return circuits.

There has probably been no litigation which furnishes a precedent as to the final decision of the highest courts in a case similar to that of the destruction of water mains by railway return currents. In the telephone cases it was possible by the use of all-wire circuits to avoid the inconvenience caused by the railway currents in the earth. In case of the water works mains there is no such remedy. The pipes are there, they form, under certain conditions, a path along which some current is bound to go. It seems, in the light of present knowledge, that these currents may be so reduced by proper precautions as to be without danger in most cases. It is equally evident, however, that the distribution system of the city should be watched with great care to detect any signs of incipient electrolysis. Whether the cost of this inspection must be borne by the city or the railway companies is a question for the courts to decide. It is to be hoped, however, that the authorities of Dayton or some other city where the water mains are being seriously damaged will take the matter into the courts and determine once for all whether the wholesale destruction of a pipe system, which must eventually result in great expense and inconvenience to a large portion of the citizens, is to be permitted unchecked. Electric railways are certainly a great boon and nothing should be done to restrict their construction and operation except for a greater public good. As a rule, however, they pay little or nothing for the right of using the streets, on which their existence practically depends, and it seems but just that they should be made wholly responsible, not only for the injury they have done to water works systems, but also for preventing further injury in the future.—Engineering Record.

SANITARY LESSONS OF THE WAR.*

By GEORGE M. STERNBERG, M.D., LL.D., Surgeon-General, U. S. Army.

As compared with the civil war and with other great wars during the present century, the mortality from wounds and disease among our troops during the war with Spain has been low. Our wounded have, to a large extent, had the advantage of prompt treatment with antiseptic dressings, and a very considerable proportion of those who were not killed outright have recovered without any mutilating operation or septic complication. The mortality from disease has also been comparatively low; but, unfortunately, during the first months of the war, that scourge of new levies of troops, typhoid fever, prevailed in many of our camps and claimed numerous victims. It is well known to sanitarians and military surgeons that, as a general rule, more soldiers succumb to disease than are killed by the bullets of the enemy, and our recent war has not been an exception in this regard. The total number of deaths reported in our enlarged army, including regulars and volunteers, from May 1, 1898, to April 30, 1899, is 6,406. Of these, 5,438 died of disease and 968 were killed in battle or died of wounds, injuries, or accident. During the civil war the number of deaths from disease was 186,216.† The number who were killed in battle or died of wounds was 93,969, or about one-half of the deaths from disease. The total deaths from disease in the Union armies from the commencement of the war to the 31st of December, 1862, was 34,326, and in the Confederate armies during the same period, 31,238.

The following table gives the monthly death rates from disease in our armies from May 1, 1898, to April 30, 1899, and, for comparison, the rates for the same period during the first twelve months of the civil war.

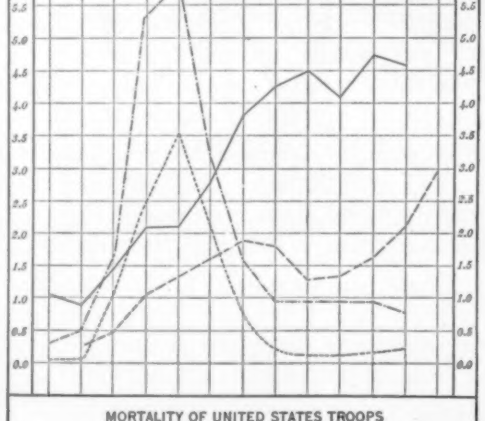
In comparing the death rates from disease during the year of the Spanish-American war (May 1, 1898, to April 30, 1899) and the first year of the civil war (May 1, 1861, to April 30, 1862) note should be taken in the first place that the mean strength in May, 1861, was only 16,161 as compared with 163,726 men in service in May, 1898. The mustering in of volunteer troops progressed more slowly in 1861 than during the recent war, so that it was not until September and October, 1861, that the mean strength assumed proportions equal to that of the months of the Spanish war. Although the number present in the camps of 1861–62, after October, 1861, was largely in excess of those aggregated during the past year, the average annual strength during both wars did not differ greatly. Nevertheless, the deaths from disease in 1861–62 numbered 10,522, while in 1898–99 they amounted only to 5,438. The death rate to the thousand of strength mounted gradually month by month in 1861–62, and indeed it did not reach its acme until February, 1863, when the rate of 6·39 was reached. In 1898, on the other hand, the acme, 5·89, was reached suddenly in September, but, owing to the sanitary measures adopted, the fall during October and November was as rapid as had been the rise.

Comparison of Monthly Death-Rates (per 1,000) from Disease.

	1861–'62.			1898–'99.		
MONTHS.	Mean strength.	Number of deaths.	Ratio per 1,000 of M. S.	Ratio per 1,000 of M. S.	Number of deaths.	Mean strength.
May......	16,161	18	1.11	.26	42	163,726
June.....	66,950	55	.82	.44	90	202,526
July	71,125	106	1.49	1.72	451	262,613
August...	112,359	242	2.15	5.21	1,400	268,507
September.	165,126	365	2.21	5.89	1,541	261,824
October ..	256,884	725	2.82	3.17	809	255,000
November.	301,848	1,145	3.79	1.51	365	242,000
December.	343,184	1,471	4.29	.84	201	240,000
January...	352,760	1,593	4.52	.85	180	211,000
February..	327,734	1,346	4.11	.87	156	180,000
March....	328,878	1,575	4.79	.90	123	136,000
April	410,416	1,881	4.58	.71	80	113,000
Annual ...	229,452	10,522	45.86	25.73	5,438	211,350

The same gradual rise is seen in the mortality statistics of typhoid fever during the civil war. The highest death rate, 2·81, was not reached until May, 1862, the thirteenth month of the aggregation of the troops, when 1,092 men died of this disease, and the fall of the rates was as gradual as the rise. On the other hand, the rise in 1898 was sudden, the maximum rate, 3·57, being reached in September, when 933 men died of this disease; but the fall during the months of October and November was as notable as the rise. This sudden suppression of the disease cannot be attributed to an exhaustion of the susceptibility of the troops to attack from this fever, as they only suffered at the rate of 12·37 to the thousand of strength during the twelve months, whereas the troops of the civil war suffered at the rate of 19·71 to the thousand. It can be attributed only to the active preventive measures that were instituted, and especially to moving the troops to fresh camp sites and to the greater care exercised in the disposal of excreta.

The following chart shows by the graphic method the same comparison as is given in the above table. The notable rise in the general death rate from disease and in that from typhoid fever alone, which occurred in August and September, was undoubtedly due to the insanitary conditions resulting from the hasty assembling of large bodies of undisciplined troops in our camps of instruction.



MORTALITY OF UNITED STATES TROOPS

The average annual mortality from typhoid fever in our regular army since the civil war has been: for the first decade (1868–77), 95 per 100,000 of mean strength (0·95 per 1,000); for the second decade (1878–87), 108 per 100,000; for the third decade (1888–97), 55 per 100,000. This latter rate compares favorably with that of many of our principal cities. For example, it is exceeded by the typhoid death rate in the city of Washington, which is 78·1 per 100,000 (average of ten years, 1888–97); by that of the city of Chicago, which is 64·4 per 100,000; by that of Pittsburg, which is 88 per 100,000. These figures, however, do not show the entire mortality in the cities mentioned as a result of typhoid fever, for without doubt many of the deaths ascribed to "malarial fevers" were in fact due to typhoid infection.

It will be seen that sanitary conditions at our military posts in time of peace, as judged by the typhoid death rate, compare favorably with those in our large cities in various parts of the country. As a matter of fact, great attention has been given to post sanitation for many years past, and through the persistent efforts of officers of the medical department great improvements have been made, especially during the past ten years. The result is shown in a reduction of the typhoid mortality from 108 per 100,000 in the ten years ending in 1887 to 55 per 100,000 in the decade ending in 1897. Hygiene is made one of the principal subjects of examination for candidates desiring appointment in the medical corps of the army, and at subsequent examinations for promotion to the grades of captain and major is given a most prominent place. It is also the most prominent subject in the course of instruction at the army medical school, where the student-officers spend five hours daily for a period of five months in practical laboratory work relating for the most part to the cause and prevention of infectious diseases. It should be remembered, however, that the army medical school was not established until the year 1893, and consequently but a small proportion of the medical officers of the army have had the advantage of this course of instruction.

But the comparatively small number of medical officers of the regular army available for duty in the large camps occupied by our volunteer troops at the outset of the war proved to be entirely inadequate to control the sanitary situation in these camps, and as a result of the conditions existing the mortality from typhoid fever in our armies during the year ending April 30, 1899, has been more than twenty-two times as great as the annual mortality in our regular army during the decade immediately preceding the war period. As compared with the first year of the civil war, however, there is a decided improvement, the typhoid mortality for the first year of the civil war having been 1,971 per 100,000 of mean strength, and for the Spanish-American war 1,237 per 100,000. Moreover, as shown by the chart, the vigorous sanitary measures enforced enabled our troops to quickly free themselves from the ravages of this infectious disease, and, while the line of typhoid mortality continued to ascend during the first year of the civil war and subsequently, it rapidly fell after the middle of September last, and for the last six months of the period under consideration has been remarkably low. Indeed, in the history of large armies the record has never heretofore been equaled.

[General Sternberg then quoted from his own prize essay on Disinfection and Personal Prophylaxis in Infectious Diseases and from the Manual for the Medical Department as to the proper measures to be taken for the disinfection of excreta, soiled bed linen, underclothing, etc.; and further reproduced Circular No. 1, issued from the surgeon-general's office at Washington on April 25, and summarized in The New York Medical Journal for August 20, 1898, giving the most explicit sanitary instructions to medical officers as to sinks, kitchen refuse, fluids to drink, isolation of infectious cases, sanitary policing, avoidance of marches during the heat of the day, use of fruit and quinine, and proper underclothing. Circular No. 5, dated August 8, 1898, calling renewed attention to Circular No. 1 and enforcing its provisions, and Circular No. 7, dated September 5, 1898, calling attention to the paragraphs relating to the disinfection of excreta from the Manual for the Medical Department, were also quoted.]

The reasons are apparent, and even in the light of our recent experience I am not sure that under similar conditions we could avoid similar results. Sanitarians generally are familiar with the difficulties attending their efforts to restrict the ravages of infectious diseases in towns and cities. They have to contend with the ignorance and reckless indifference of a large proportion of the population, with the ignorance and mistaken parsimony of legislative bodies, and to some extent with the negligence or perfunctory performance of duties assigned to them by agents of the health department, often appointed as a reward for political services rather than on account of their special fitness for the work. Perhaps it was too much to expect that typhoid fever should be excluded from our camps, unprovided with sewers and occupied by new levies of troops, having for the most part inexperienced officers both of the line and in the staff departments. The medical officers of regiments were appointed by the governors of States, and, as a rule, were competent professionally, but they were called upon to assume new responsibilities for which they had no special training. Unfortunately, hygiene and practical sanitation are subjects which receive little attention in our medical schools or from physicians and surgeons engaged in the practice of medicine. But even in those cases in which the regimental surgeon was fully aware of the importance of camp sanitation and urgent in his sanitary recommendations, he was unable to control the sanitary situation unless the regimental and company officers enforced the necessary measures for protecting the health of the command. And just here is the fundamental difficulty when we are dealing with new levies of troops. The officers and enlisted men of our volunteer regiments

* Abstract of a paper read at the meeting of the American Medical Association, at Columbus, Ohio, June 8, 1899.—From The New York Medical Journal.

† In addition to this, 24,184 deaths are recorded as from unknown causes, and probably most of these deaths were from disease.

were, as a rule, intelligent, patriotic, and brave, but they were not disciplined. Each man was in the habit of judging for himself and of acting in accordance with his individual judgment. Discipline consists essentially in an unquestioning obedience to orders from those having proper authority to give them. Trained officers cannot at once establish discipline among untrained troops, and when both officers and enlisted men are without military experience, it is evident that, with the best material, time will be required for the establishment of discipline. And in the absence of discipline it is impracticable to enforce proper sanitary regulations in camp. The surgeon-general may formulate sanitary regulations, and the general commanding an army corps or a division may issue the necessary orders, but in the absence of discipline these orders will not be enforced. A reckless recruit will drink the water which has been condemned as unsafe, and at night will defile the ground in the vicinity of his tent rather than visit the company sink, which, possibly, is in a disgusting and unsanitary condition because of a failure to carry out the orders to cover the surface of excreta "with fresh earth, or quicklime, or ashes, three times a day."

And now, in order that the "sanitary lessons of the war" may not be lost sight of, and may be made available hereafter if we should again have occasion to assemble a large army on short notice, I consider it my duty to speak plainly with reference to one of the principal causes of the epidemic prevalence of typhoid fever in our camps. As a rule, this disease was called by some other name by the medical officers on duty with regiments who first saw the cases. Usually it was assumed to be malarial fever, and was treated as such until the patient became so sick that it was found necessary to send him to the division field hospital or to a general hospital. This general statement is based upon the carefully made investigations of a board of medical officers appointed upon my recommendation.

In a paper read by Major Victor C. Vaughan at the meeting of the Association of American Physicians, held in Washington city early in May, which paper may be regarded as a preliminary report of the board, the following statements are made:

"We had not finished our first day's work at Camp Alger before we saw that one factor in the problem must be thoroughly dealt with before we could hope to reach a satisfactory solution. Fortunately, we promptly took steps to acquaint ourselves with this factor. It cannot be denied that scientific medicine would have gained much had this factor been provided for at an earlier date. I refer to the question of the scientific diagnosis of typhoid fever. In the division hospital at Camp Alger we found most of the febrile cases diagnosed as malarial. We believed that they were typhoid fever, but the surgeon in charge had diagnosed them malaria. We requested that competent men, properly equipped for making blood examinations for the malarial plasmodium and the Widal test, should be sent to each of the larger camps. The surgeon-general acted promptly on this suggestion.

"When we began to study the regimental sick reports we found that, in order to obtain satisfactory information, we must endeavor to ascertain how many cases of typhoid fever there were in each regiment, and it soon became evident that the regimental sick reports did not give this information. Of two regiments in the same brigade, one had more than two hundred cases of typhoid fever, as shown by the regimental reports, while the other regiment on like evidence had only two cases; but the records of the second regiment show more than two hundred cases of protracted malaria, and these furnished a mortality as high as that of the typhoid fever in the first regiment. For the reasons already given, we have included all the protracted malarias among our list of the typhoids. It may be asked how long we have considered it necessary for a so-called malaria to run in order to make it a probable typhoid. In answer to this I will state that we have regarded all so-called malarias of ten days or more in duration as possible cases of typhoid fever. We think that the great rarity of true malaria, and the readiness with which these rare cases have yielded to quinine, and the fact that quinine was so generally administered, justifies us in this conclusion. Practically, however, the number of doubtful cases is exceedingly small.

"Typhoid fever was not only diagnosticated as malaria, but it was covered up by many other names. In one regiment the death rate from indigestion amounted to 15 per cent. of the completed cases. In another regiment at Chickamauga dengue is a frequent diagnosis of many cases which undoubtedly were typhoid fever. . . ."

This failure to recognize typhoid fever during its earlier stages is an error of diagnosis which was made on a very extensive scale during the civil war, has been made on an equally extensive scale by surgeons of the British army on duty with troops in India, and is still being made by a majority of the practitioners of medicine in certain parts of our own country.

[The surgeon-general then made extensive quotations from his own work on Malaria and Malarial Diseases; from Dr. George B. Wood's Practice of Medicine (ninth edition); Dr. James C. Wilson's Treatise on the Continued Fevers; Dr. W. W. Johnston's paper (American Journal of the Medical Sciences, October, 1882) On the Mild Forms of Continued Fever which Prevail in Washington; Sir Joseph Fayrer's recent work on Fever in India; and from Prof. Borelli's articles (Medical Times and Gazette, London, July 8, 1876) on Naples Fever, all tending to substantiate the thesis that the mistaken diagnosis of typhoid fever as malarial fevers of various kinds prevailed very widely, though not more, perhaps, in this country than in continental Europe and British India. The great difficulty of forming an early correct diagnosis from clinical symptoms was emphasized; inasmuch as while remittent fevers frequently assumed in their later stages a continued form, and malarial fevers of a remittent or continued type often gave rise to a "typhoid condition," typhoid fever, on the other hand, frequently showed a decided remittent character during the first week quite independently of any malarial complication, and still more so when occurring in a malarious subject. The error in diagnosis once made might be persisted in in the later stages, either under the continued influence of the preconceived and dominant idea, or from the reluctance to confess to an error.]

Finally, the principal lessons to be derived from our recent experience may be stated as follows:

A trained medical corps, hardly adequate for an army of twenty-five thousand men, cannot control the sanitary situation when this army is quickly expanded to two hundred and fifty thousand. Physicians and surgeons from civil life, however well qualified professionally, as a rule are not prepared to assume the responsibilities of medical officers charged with administrative duties and the sanitary supervision of camps. The proper performance of such duties cannot be expected from a physician without military training or experience, no matter how distinguished a position he may have held in civil life.

Courage and patriotism on the part of line officers and enlisted men cannot take the place of knowledge and experience. New levies of troops are, as a rule, ignorant of the first principles of camp sanitation, and reckless as to the consequences of their neglect of prescribed sanitary regulations. Therefore, training and discipline are essential factors in the preservation of the health of soldiers in garrison or in the field.

The value of the aphorism "In time of peace prepare for war" has received additional support. This preparation should include a corps of trained medical officers larger than is absolutely necessary for the army on a peace basis, and systematic instruction in military medicine and hygiene for the medical officers of the national guard as well as for those of the regular army; also, instruction of line officers in the elements of hygiene, and especially in camp sanitation. It should also include the establishment of camping grounds in various parts of the country, having an ample supply of pure water, a proper system of sewers, etc. If our volunteers could have been assembled in such camps during the late war, a saving in lives and money would have resulted which would without doubt have demonstrated the economy of such preparation for war in time of peace.

WHY DO THE DIALS OF OUR TIMEPIECES HAVE TWELVE DIVISIONS?*

ALTHOUGH our arithmetic is decimal, and we usually count by tens, hundreds, and thousands, a remarkable exception occurs with respect to time. Instead of counting by ten, we count by twelve; instead of dividing the hour into a hundred minutes, we divide it into only sixty, and the minutes into sixty seconds.

An archæologist might imagine that our division of time had not been derived from the same ethnographic source as our decimal arithmetic. He would be inclined to believe that our civilization had borrowed it from another civilization. He might regard it as more advanced than our own inheritance, but, on the other hand, quite in arrear of the development of the nineteenth century.

The archæologist would be right; his surmises would be verified by the historical data respecting the old communities of Western Asia and their usages collected during the last twenty or thirty years.

The count of the hours by twelve and their subdivision by sixty was commenced by the Accadians, living within the territory of the Euphrates and the Tigris more than forty centuries ago.† It was adopted in Greece at a time when the population, who counted simply by tens, because they counted on their fingers, were yet in a barbarous state.

This primitive method of numbering the hours has survived. It is curious to notice the persistency with which established usages are perpetuated and the tenacity of their anomalies and imperfections. It was remarked that there were about twelve lunations in the year, and consequently the route of the sun was divided on the circumference of the astronomical globe into twelve stages or compartments, in each of which this heavenly body was in conjunction with the moon.

In the celestial divisions, in which the sun did not appear at night, the principal stars were noted. By these observations twelve constellations were formed in the extent of the zodiac, in each of which a given star was taken as the type or representative star, whose rising denoted the commencement of the corresponding hour.

Before the invention of mechanical timepieces, a watchman was on the lookout at night for the indicating stars, and as soon as one was seen he cried out the hour. It was soon found that the twelfth of the diurnal period was rather long. The intervals were divided into halves called double hours, numbering twelve, and there were also single hours numbering twenty-four. The use of the latter became general and has been preserved. It was prevalent not only at Nineveh and Babylon, but in Egypt.

An astronomical figure of the thirteenth century before our era, engraved on the ceiling of a royal Egyptian tomb, shows, for the duration of the night, the twelve stars whose appearance on the horizon at Thebes marks the commencement of the twelve single hours from twilight to dawn. It is thus clear how the duodecimal division commenced.

It spread at a very remote period to Chaldea and to Egypt. It was adopted by the Greeks, who communicated it to the Romans, whom we have followed. It was a feature of a special civilization, and never had a universal character. It was the creation of an educated and observing people, but not the creation of uncultured nature, like the decimal arithmetic, which arises everywhere because everywhere man has ten fingers.

The Chinese, more logical, counted ten hours, where the Accadians counted twelve. Other peoples of western Asia divided the diurnal period into sixty parts. The Mexicans made a division of eight and the Mayans of sixteen parts. There were as many systems as there were distinct origins. When the Accadians originated the division of twelve hours, they recognized the fact that the number 12 is, as an arithmetical base, preferable to the number 10. The latter is exactly divisible only by 2 and by 5, while 12 can be exactly divided by 2, by 3, by 4, and by 6, which is a great advantage for serving as a measure. The Scandinavians had observed the same thing, and reckoned not by tens, but by dozens.

In certain provinces of Sweden traces of this usage still survive, which was not abandoned when our system of arithmetic was introduced. The people still calculate by groups of 12 and by groups of 12 times 12, or 144. The first are called to-day great tens, in contradistinction to small tens, consisting of ten units; and the second great hundreds, to distinguish them from little hundreds, consisting of one hundred units.

Arithmetic with the base of 12 is more erudite than that with the base of 10, which is natural and primitive. It attests an intellectual development superior to that of the savage, who goes no further than his ten fingers, or at times his ten toes added to his ten fingers. The bases 5, 10, and 20, multiples of 5, were the first in every community. They were soon confounded with the base of 10, which was certainly the first arithmetical measure in Chaldea, as elsewhere.

When the division of the time into twelve hours had been instituted and the advantages of the base twelve had been recognized, an attempt was made to combine the two systems. It was then that the sexagesimal division was introduced, the number 60 containing both 12 and 10. In the numerical series it is the first number comprising the two divisions.

This idea was embraced so enthusiastically that the division by sixties was applied to everything. All the units of weight, of length, of capacity, at Babylon and at Nineveh, were divided into units or primes, of which there were 60 in the principal unit. The prime was divided into 60 seconds; the second into 60 thirds; the third into 60 fourths, and so on indefinitely. It was a complete and perfect system.

It has been transmitted to us, and survives in the method of designating the time. The people who inaugurated such a system were more cultured than the barbarian Grecians, to whom it was communicated. To-day the maintenance of their computation of hours, minutes, and seconds is an anachronism, and compared with our scientific advancement, a mark of inferiority. Is not the repetition of the twelve hours a defect in our dials?

The unit is the diurnal period, the rotation of the globe from noon to noon or from midnight to midnight. It is perfectly illogical to make two halves and to recommence the counting in each of them. From this alone it might be imagined that our division of the time had its origin in an age when different methods had to be employed to determine the hour during the day and to ascertain it at night. The suspicion would be well founded. The ancient astronomical peoples, to whom we owe the plan of our dials, were obliged to ascertain the hour at night by the stars, and in the day by the sun. The processes were quite distinct.

At night it was necessary for the watchman to look for the rising of the typical stars. Not only was a clear sky requisite, but a perfectly pure atmosphere, exempt from fogs at the horizon. During the day, on the contrary, the observation of the gnomon was by other persons. The day watcher and the night watcher belonged to two distinct professions, meeting only at the time of changing watch; thus the night hours were entirely separated from those of the day, and the calculation commenced from sunset, and they were twelve in number.

At sunrise commenced the day hours, also numbering twelve. That is why the hands on our dials make two revolutions instead of one during the diurnal period, or as the Greeks say, *nychthemeron*, the full natural day of twenty-four hours. The double revolution on the dial is derived from a period when there were no mechanical timepieces, not even water-clocks, and when the dial of the heavens was the only one that could be consulted. The celestial dial was double: that of the stars during the night, and that of the sun during the day.

Our clocks thus bear upon the face the souvenir of a very primitive period of civilization. It is an infantile feature, which has no reason for existence, and is a real inconvenience. What simplicity would there not be in designating the hours continuously from one day to the next? As it is, we are troubled to distinguish between the hours before noon and those after noon.

When we receive a telegram from a distant city, as from San Francisco or Melbourne, where the local time differs considerably from ours, we may be in doubt whether it was forwarded before or after one that we ourselves had dispatched. In our railway time tables for long routes, when we are considering the arrival of a train commencing its course the night or the day before, it is often difficult to tell whether a given figure represents the morning or the evening hour.

In certain countries, a system of very thick printed lines has been adopted to designate the night hours, meaning generally from six o'clock in the evening to six o'clock in the morning. But close attention is necessary in following this distinction, because one is a little disconcerted in summer traveling by the extension of the night from six o'clock in the evening to broad daylight at six in the morning.

In the railway service, notably that of special trains, whose hours are never anticipated before their announcement, their computation from one to twenty-four would be of great utility and at times might prevent dangerous confusion. It is probably the first reform that will be introduced in the horary system. Railway officers are interested in taking the initiative. If the hours were given continuously, as 13, 14, 15, etc., after the noon hour, the public would become habituated readily and quickly to the change.

Notwithstanding all that our timepieces have preserved of the vestiges of an antiquity of forty centuries, the progress already realized in the method of calculating the time must be kept in view, and it must not be imagined that further progress is out of the question.

The night hours become equal to those of the day, after having remained different for more than thirty-seven centuries. As the point of departure, the noon hour, does not change from day to day, the uniformity remains absolute. But we divide our hours into two series, two revolutions on the dial, evident remains of the period when there were two kinds of hours.

Why commence the computation again when we are half way through, at the risk of possible confusion? Why not rid ourselves of all uncertainty? There is but one reason, and but one answer: Because the present system has the sanction of four thousand years.

* From the French of M. Houzeau, Director of the Brussels Observatory.

† The Accadians were the highlanders of Mesopotamia, and their attainments and usages developed into the Chaldean civilization.—Note by translator.

The operation of adjusting the gears of the latest models of the chainless requires little, if any, more skill than the nice adjustment of the chain.

THE DIFFRACTION PROCESS OF COLOR PHOTOGRAPHY.

By R. W. WOOD, Assistant Professor of Physics, University of Wisconsin.

THE most satisfactory solution of the problem of color photography will be the discovery of some chemical compound which, when exposed to light of various colors, will assume a hue similar to that of the light which falls upon it. Early experiments of Herschel and Becquerel with chloride of silver seemed to give promise that such a compound could be obtained, for with this material they succeeded in making colored pictures of the solar spectrum. These, however, could not be made permanent. It was at first supposed that the action of the light actually produced colored compounds of silver, but we now know that the colors were due to another cause, to understand which we shall have to consider the very beautiful process devised by Gabriel Lippmann, about which so much has been said of late.

The colors of the Lippmann photographs are produced in the same way as the rainbow tints of the soap bubble. To explain in detail how these tints are produced would take too much space, but a brief indication may be intelligible. We shall have to begin by assuming that when white light, which is simply a mixture of all colors, falls upon an exceedingly thin film of any transparent substance, certain colors are reflected, and the others pass through. The colors thus produced are known as interference colors, since they are produced by the interference of the waves of light. The color of the reflected light depends on the thickness of the film, and if we could arrange our bubble so that the soap film should have just the right thickness in every place, it is easy to see that the colors on it might form a picture, and this is precisely what Lippmann has done, except that he has chosen something less transient than the soap bubble. He has so arranged the photographic plate that when red light falls on it, there is produced a film of just the right thickness to reflect red light, and when green light falls on it, there is formed a film of slightly different thickness, which will reflect only green light. The method by which he accomplishes this is not very difficult to understand. The film of the photographic plate is backed by a mercury surface, which reflects the light back through the film. The reflected waves thereupon interfere with those coming through the film, and nodes are formed, exactly like the nodes on a violin string when sounding a harmonic. Now the distance between the nodes corresponds to the length of the waves, or in other words to the color of the light, and the sensitive silver compound in the film is only affected at points between the nodes, instead of throughout the entire thickness of the film, as is ordinarily the case. The result of this is that on developing the plate, the reduced silver is formed in thin layers or films, instead of in a compact mass, and the films have just the right thickness to reflect light of that color by which they were formed.

Lippmann's method is the most scientific and most beautiful of all the methods thus far devised, though unfortunately the difficulties in operating it are so serious that as yet it cannot be used outside the laboratory.

All the other processes for producing color photographs thus far devised are indirect, and depend on the fact that any color can be imitated by a proper mixture of the three primary colors, red, green, and blue. The first principles of all these processes were laid down by Ducos de Hauron in 1868, and have been elaborated along different lines by half a score of investigators in this and other countries. Several methods have been invented which yield very satisfactory results, but which require considerable machinery. For instance, three negatives are taken under red, green, and blue glass, and from these ordinary lantern slides are made. If these slides are projected, superposed on a screen through the red, green, and blue glasses by means of a triple lantern, a fairly faithful representation of the original is produced. The triple lantern, however, is expensive, and some simpler contrivance for combining the pictures is desirable. Ives has accomplished this with his helio-chromoscope, by means of which the reflected images of the slides seen through colored glasses are seen superposed. Another method was brought out almost simultaneously by Joly, of Edinburgh, and MacDonough, of Chicago, which consists in taking the negative through a transparent screen ruled with the primary colors, red, green, and blue. From this a positive on glass is made, which, when viewed through another screen ruled in colors, reproduces the original with considerable fidelity. Still another method consists in making half-tone or lithographic plates from the three original negatives, and printing from these with colored inks.

All of these methods reproduce the colors either through the instrumentality of colored screens or pigments. It occurred to me that by employing the diffraction grating, colored screens and pigments could be eliminated from the finished picture, and that duplicates could be made as easily as blue prints are struck off from an ordinary negative. The method was completely worked on paper before a single experiment was tried, and the first picture made reproduced the colors of the original perfectly.

To make clear the manner in which the colors are produced, I must first devote a little space to the construction and properties of the diffraction grating. If a plate of glass be ruled with fine parallel, equidistant lines, by means of a diamond point, the plate thus prepared possesses properties somewhat analogous to those of a prism. Such a plate is known as a diffraction grating. As many as 40,000 lines have been ruled in the space of a single inch, though the plates which I have used for producing color photographs have only about 2,000. These gratings are ruled with a machine known as a dividing engine, by which a diamond point is carried back and forth across the plate, and between each trip the plate is advanced, by means of a screw, say a ten-thousandth part of an inch perpendicular to the direction in which the diamond is moving. Prof. Rowland, of Johns Hopkins University, has designed and has had constructed the most perfect dividing engines that have ever been made. The machines are set up in a sub-cellar, deep down under the laboratory, where they can be kept at a constant temperature, for the slightest variation in the temperature causes expansion or contraction of the parts of the engine sufficient to impair the accuracy of the ruling. Before the engine is started the doors are locked, and no one enters the room until the operation is over. The machine goes on ruling day and night, and in from two to six days, according to the total number of lines required, the grating is finished. The lines are so fine that they can only be seen with a powerful microscope, and yet they collectively exercise a most remarkable effect on light passing through the plate. If we hold such a grating in front of the eye and look at a gas flame or incandescent lamp through it, we shall see, on each side of the lamp, beautiful rainbow-tinted bands of light, or spectra. We know that when white light passes through a prism, the different colors are deviated by different amounts, and that a spectrum is formed of which the blue is the most deviated, and the red the least. Now the diffraction grating acts something like the prism, except that it deviates the red the most, and the blue the least, produces several spectra, and generally, though not necessarily, gives an uncolored central image between the spectra. If, for instance, we place a diffraction grating in front of a convex lens, and form an image of the lamp flame by means of the lens on a sheet of paper, we shall see the colored spectra on each side of the image of the flame, as is shown in Fig. 1. The finer the spacing of the grating, the farther removed from the central image are the lateral spectra.

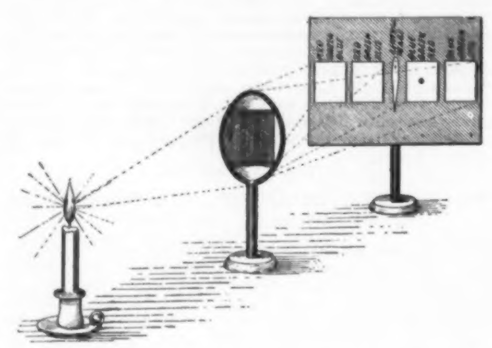


FIG. 1.—DIFFRACTION GRATING AND LENS SHOWING DISPERSION OF COLORS.

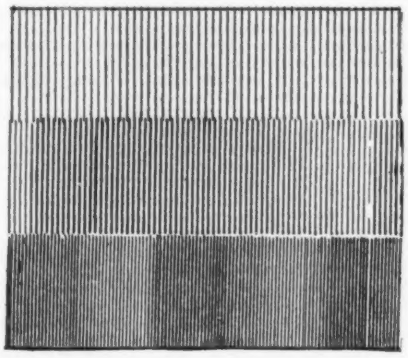
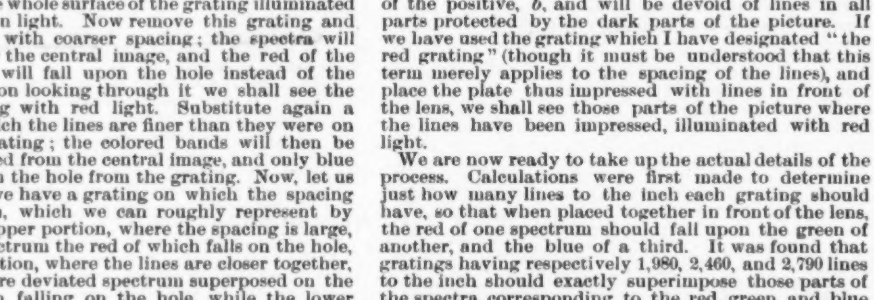


FIG. 2.—THREE GRADES OF GRATINGS.

We are now prepared to consider the question of how colored photographs can be produced by the diffraction grating. Consider the black spot in the middle of the first spectrum to the right as a small hole perforated in the paper screen. Only green light comes to this spot from the grating, and consequently, if we go around behind the screen and look through the hole, we shall see the whole surface of the grating illuminated with pure green light. Now remove this grating and substitute one with coarser spacing; the spectra will then be nearer the central image, and the red of the first spectrum will fall upon the hole instead of the green, so that on looking through it we shall see the grating shining with red light. Substitute again a grating on which the lines are finer than they were on the original grating; the colored bands will then be further removed from the central image, and only blue light will reach the hole from the grating. Now, let us suppose that we have a grating on which the spacing is not uniform, which we can roughly represent by Fig. 2. The upper portion, where the spacing is large, will form a spectrum the red of which falls on the hole, the middle portion, where the lines are closer together, will form a more deviated spectrum superposed on the first, the green falling on the hole, while the lower strip will form a third spectrum, still more deviated, but superposed on the other two, with its blue portion over the hole. The aperture therefore receives red light from the upper strip, green light from the middle, and blue light from the lower, and if we look through it we shall see the strips illuminated in these colors.



STAINED GLASS WINDOW. RED SCREEN POSITIVE. GREEN SCREEN POSITIVE.

FIG. 3.

We can now understand how a picture in three colors could be produced by a proper distribution of patches containing ruled lines of three different spacings. For convenience I shall designate the three gratings previously mentioned as the red, the green, and blue gratings, meaning simply that the deviation of the red rays by the first is the same as the deviation of the green by the second, and of the blue by the third.

The production of a photograph in color on the principles laid down seems, at first sight, a difficult task. It is in reality quite simple. The objection to the three-plate process has been the difficulty of combining the three pictures into a single one, which has thus far only been accomplished by the triple lantern, Ives' kromoscope, and rather imperfectly by means of lithographic and half-tone processes. What we require is a means of making a single print from the three negatives, which shall show the colors of the original.

To illustrate the difficulty of this, let us take the case of the yellows in the picture; they are represented as high lights in the positives made with the red and green screens, since yellow light goes through both of these screens. When we project the positives with the triple lantern through red and green glass, the yellows of the picture send both red and green light to the screen, and we know that, when these two lights are mixed, they produce the sensation of yellow. But how can we make a print in which the yellows shall send both red and green light to the eye? If we make prints in gelatine and stain them, the result will not be yellow, for the green falls over the red, and such a combination transmits hardly any light at all. In other words, we cannot mix the light by superposing colored films.

It was while considering this question that the idea of using the diffraction grating occurred to me. If we have two sets of lines, one of which sends red light to the eye, and the other green, and superpose them, each set will send its own color independently of the other, and the result should be yellow. Inasmuch as diffraction gratings can be easily produced by photography, it seemed feasible to work up a process along these lines. If we coat a glass plate with a thin film of gelatine stained with bichromate of potash, expose it to sunlight under a diffraction grating, and then wash it in warm water, we shall obtain a copy of the grating which can hardly be told from the original. If, therefore, we take a positive on glass made from the negative taken under the red screen, and expose it to sunlight over a plate coated with bichromated gelatine, interposing a diffraction grating between the two, we shall obtain an impression of the lines on the portions of the plate which are under the transparent parts of the picture. To illustrate: Suppose that *b* in Fig. 3 represents the positive (taken under a red screen) of a stained glass window, *a*, colored as shown. The print taken on the gelatine under this picture, with the grating interposed between the two, will have the lines impressed on it in patches corresponding to the transparent parts of the positive, *b*, and will be devoid of lines in all parts protected by the dark parts of the picture. If we have used the grating which I have designated "the red grating" (though it must be understood that this term merely applies to the spacing of the lines), and place the plate thus impressed with lines in front of the lens, we shall see those parts of the picture where the lines have been impressed, illuminated with red light.

We are now ready to take up the actual details of the process. Calculations were first made to determine just how many lines to the inch each grating should have, so that when placed together in front of the lens, the red of one spectrum should fall upon the green of another, and the blue of a third. It was found that gratings having respectively 1,980, 2,460, and 2,790 lines to the inch should exactly superimpose those parts of the spectra corresponding to the red, green, and blue tints of the Young-Helmholtz theory of color vision. These exact calculations were necessary, since the three primary colors must be of exactly the right shades if a true representation of the original is to be secured. Gratings of this spacing were at once ordered from Cornell University, where there is a dividing engine that will rule any desired number of lines to the inch, and in the meantime experiments were commenced with two small gratings which we had in our laboratory, which had approximately the right spacing for the red and green.

For simplicity I shall consider first the production of a color photograph with two gratings, giving the details of the first experiment tried. The subject chosen was a stained glass window in three colors, red, green, and yellow. This window is shown in Fig. 3, *a*, the colors of the pattern being indicated. Two negatives of this were taken, one under a red glass, the other under a green. From these positives were made, which are shown in Fig. 3, *b* and *c*. The four-petaled figure was deep red, the fleur-de-lis figures were green, and the central circle yellow. It will be seen that the yellow shows light in both pictures, since it goes through both color screens. A plate of glass coated with bichromated gelatine was then exposed under the first or red positive, the "red" grating photographed on very thin glass being placed between; an impression of the grating lines was made on those parts of the plate lying under the clear parts of the picture. A second exposure was then made under the green positive, with the

"green" grating interposed, care being taken to secure perfect registration by means of marks on the plates. On washing the plate in warm water, the lines were brought out and the picture was finished. Fig. 4 represents diagrammatically the distribution of the lines; in the red parts we have the coarse spacing, in the green the finer, and in the yellow both spacings superposed.

It seems remarkable that it should be possible to print several sets of lines in any one space and have all come out with equal intensity. Microscopical examination of the pictures leads me to believe that the different sets of lines exist at different depths in the gelatine film. This is, however, only true for the first picture printed by successive exposures under the gratings.

In order to see the picture in color we must employ a viewing apparatus consisting of a lens and a perforated

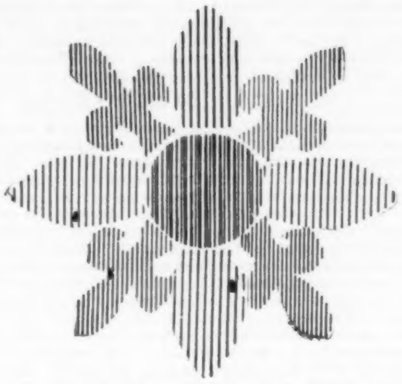


FIG. 4.—THE COMBINATION OF THE DIFFERENT COLOR LINES.

screen for bringing the eye into the right place. This is shown in Fig. 5. Placing the picture in front of the lens and pointing the apparatus toward a lamp, the original colors of the window flash out with great brilliancy. If the viewing apparatus be pointed in the right direction with reference to the light, any diffraction photograph made from the same set of gratings will appear in its natural colors. If the instrument is turned slowly, the eye will be brought successively into different parts of the overlapping spectra, and the colors of the picture will change in a kaleidoscopic manner, most pleasing to watch, though not true to nature.

The first picture taken was only an inch square, being limited by the size of the grating; but as it is very easy to copy gratings by photography, it was not difficult to construct larger ones by making successive prints on gelatine like the squares on a checker board. Large gratings made in this way work quite as well for making pictures as those of the size ruled on a dividing engine, and this is a very fortunate thing, since no engine yet constructed will draw a line more than two or three inches long. From the two small gratings that I commenced with I prepared copies three inches square, and in the subsequent experiments used these instead of the originals. A lot of Brazilian butterflies pinned on a piece of red and yellow Roman silk came out in a most beautiful manner, as did also a brass lamp with a red silk shade and some books with gilt letters on the back.

Returning now to the diagram of the photograph of the stained glass window (Fig. 4), it will be seen that in the yellows, where both sets of lines are superposed, there are periodic bands of light and shade. This can be best seen in the central circle by looking at it with the eyes partly closed. A similar effect can often be seen by looking at one picket fence through another, particularly if we are in motion at the time, when shadowy bands seem to flit along over the pickets. This effect is shown very well in Fig. 6. The distance between the dark bands depends on the relative spacing of the two sets of lines. Two sets of lines of two different relative spacings were ruled with a pen, overlapping one another

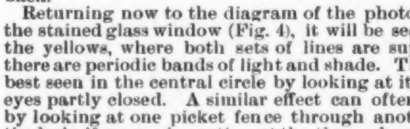


FIG. 5.—VIEWING INSTRUMENT.

and the formation of the dark bands is clearly shown. If the lines are not parallel the bands will be oblique, as is the case in the figure. In the yellow portion of our picture we should consequently expect the microscope to reveal bands of a similar nature, and this is precisely what it does. In Fig. 7 we have a photograph of two very small portions of one of the color photographs taken through a microscope. One of these shows but one set of lines, and represents a small bit from the red part of the picture. The other is from a yellow part of the picture, and the dark bands, caused by the two sets of lines, are clearly shown. It is difficult to make out both sets of lines, as one set seems to be deeper down in the gelatine film than the other, and both cannot be brought into focus at the same time. Their presence is clearly indicated however by the shadowy bands.

To form a picture in which all the colors appear, requires three gratings. Purples are formed by the superposed red and blue gratings, and white by all three. Dark reds, ochers, and browns, I find are rendered with fidelity, and the only difference in the picture, between these tones and the brighter ones, is that where they occur the grating lines are not so strongly impressed. Where there are no lines at all the picture sends no light to the eye, and appears dead black. Thus all possible colors are accounted for.

One of the most interesting things about the pictures is that duplicates can be made by contact printing in sunlight. It is as easy to make copies as it is to make blue-prints. All we have to do is to dissolve a little gelatine in warm water, add a little bichromate of potash, and flow the solution over a glass plate. In half an hour it is dry, and if we expose the plate thus sensitized to sunlight for half a minute under our diffraction photograph, and wash it a moment in warm water, as soon as it is dry it shows the same colors as the original, and is in fact indistinguishable from it.

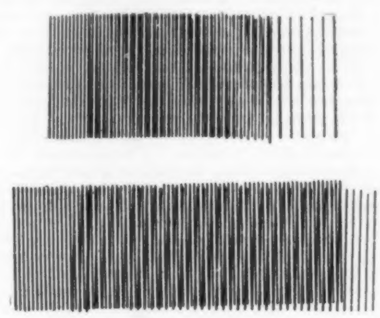


FIG. 6.—MERGING OF YELLOW COLOR LINES.

From this copy we can print others, all of which will be positive, a feature in which this photographic process differs from all others.

Another point of interest is that the picture can be seen with both eyes simultaneously. We have seen that a grating produces similar spectra on each side of the central image of the flame cast by the lens. In the same way the diffraction pictures form similar superposed spectra on each side of the central image. Thus by choosing a lens of proper focal length, we can arrange our viewing apparatus so that both eyes can be brought into the proper position for seeing the picture. This can be easily understood by referring to Fig. 8, which represents diagrammatically the sets of superposed spectra, produced on each side of the central image. In the figure they are separated from one another; in reality they are all superposed on the eye-

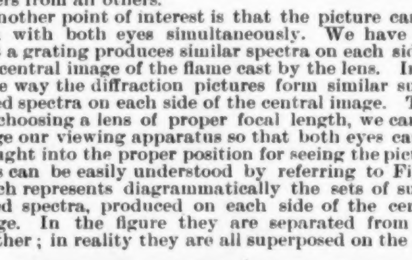


FIG. 7. — MICROSCOPIC MAGNIFICATION OF THE YELLOW AND RED LINES FROM MINUTE SECTIONS OF GRATING.

holes. The position of the eyes is indicated, and it will be seen that each eye is in that part of the multiple spectra where the red, green and blue overlap. The apparatus used for viewing the pictures with both eyes is the same as that previously described, except that it has two eye-holes, the central image of the flame falling midway between them.

By means of a suitable electric lantern, or still better by employing sunlight, the pictures can be thrown on a screen in their natural colors, and thus be shown to a large number of people at once.

Eventually I hope to be able to do away entirely with the necessity of taking three negatives, and printing three positives from them. This can probably be done by exposing a single plate under red, green and

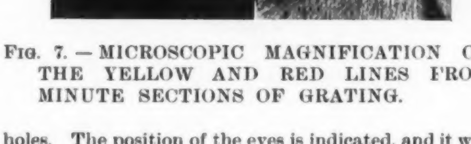


FIG. 8.—PLAN OF THE VIEWING APPARATUS.

blue screens, on the surface of which diffraction gratings have been photographed. The grating screens will be located within the camera, and swung in succession into position in front of and in contact with the plate, by means of little levers on the outside of the camera.

The plate when developed in the ordinary way will be a black and white negative, broken up into very fine lines of course, but when seen in the viewing apparatus will appear as a colored positive. Positive copies can be made from it on bichromated gelatine, in the manner already described.

A plate sensitive to all colors, and of much finer grain than the commercial plates, will be required, though I have produced the blue components of the picture on an ordinary plate in this manner, the negative appearing as a blue positive in the viewing apparatus.

FROZEN FOOD.

By LEONARD W. LILLINGSTON.

How to preserve meat was a problem which for a long time exercised the minds of inventors. It is on the records that between 1691 and 1855 more than a hundred patents were taken out for different processes. No one man lit upon the idea of freezing meat. The knowledge that intense cold prevented decomposition of animal tissue was of course common to everybody; the only difficulty was in making practical use of it. And this was not overcome until 1880, when 400 frozen carcasses of Australian sheep were landed at the London docks. Before that time, indeed, as early as 1862, a small trade had been done with the colonies in salted mutton, while meat preserved by being placed in tubs, and boiling fat poured over it, had also been successfully landed. Tinned meat, too, was in vogue then as now, and with the same objection, that the excessive cooking it had to undergo deprived it of its flavor. It is true that an ingenious gentleman named Morgan suggested a method by which the veins of the animals were, shortly after death, filled with brine solution; but this, like many other preservatives, seems to have had but a short-lived reputation, so that The Times hailed the advent of the first consignment of frozen food as a "prodigious fact." The British public would, in theory, have nothing to do with Australian mutton; but somebody appears to have eaten it, for the next year 17,275 carcasses came into this country. It seems extremely probable, in view of the extreme prejudice with which frozen meat was at first regarded, that a great deal of it was sold as home fed, so that the consumer, through his own ignorance and folly, not only ate colonial mutton against his wishes, but had to pay more than its market value. This is sometimes the case now, but not so often as is supposed. There is scarcely a large town throughout the kingdom without its "colonial meat stores," and both beef and mutton from the antipodes are keenly appreciated by the working classes. Perhaps the prejudice was mainly a middle class one after after all, for it should be remembered that, until the introduction of Australian and New Zealand meat, beef and mutton were beyond the reach of the bulk of the workers. For the mouths were multiplying and the home supply was growing smaller and smaller year by year. Whatever may be the arguments for or against the use of animal food, it is a significant fact that the wealthier classes, who could afford meat upon their tables every day, had an average life of fifty-five years, while among the poor it was no higher than thirty. As to the prejudice, we may reflect that we have had rather more than a decade in which to digest the fact that the mutton on our table may have cropped pasture land 13,000 miles away, and been dead from six to nine months, or even longer. For it can be kept an indefinite length of time; there are carcasses of mutton in the cold storage chambers of Nelson's Wharf, on the banks of the Thames at Lambeth, which have been there seven years, and are apparently none the worse for it. These, however, are retained experimentally; the average time is from six weeks to two months. It is only fair to add that tinned meat still holds the record for longevity. Witness the case of that preserved mutton vouched for by Dr. Letheby, in his Cantor lecture, which had been tinned forty-four years and was still in condition at the end of that time.

Those tins had an adventurous career. In 1824 they were wrecked in the good ship "Fury," and cast ashore with other stores on the beach at Prince's Inlet. They were found by Sir John Ross eight years afterward in a state of perfect preservation, having passed through alarming variations of temperature annually—from ninety-two degrees below zero to eighty degrees above—and withstood the attacks of savage beasts, perhaps of savage men. For sixteen years more they lay there, broiled and frozen alternately; then H.M.S. "Investigator" came upon the scene, and still the contents were in good condition. For nearly a quarter of a century they had withstood the climatic rigors, and, as was but natural, some of them were brought home again, where they lived on in honored old age, till they were brought under the notice of Dr. Letheby.

It is a curious reflection that, if you could have imported sheep into Australia before 1787, they would have produced an even greater sensation than the frozen carcasses did here in 1880. For there were no sheep in Australia until they were introduced by the first convict settlers at Botany Bay. The vessels called at the Cape of Good Hope on the way out, and took on board the progenitors of the vast flocks which now roam the Australian plains.

They became so numerous that the colonists did not know what on earth to do with them. If you had a population of a little less than four millions—that is, scarcely less than one four-hundredth of the population of the world—and yet possessed one fourth of the world's sheep, you would be in a pretty quandary. And that was the exact position of Australia. If the colonists ate mutton at every meal, and had five meals a day, there would still be a surplus. And so it came about that in 1880 sheep were being bred in the colony in thousands for their skins and tallow only. The very finest mutton was not worth putting on the market, and was converted into manure for the land.

Before the Food Committee of the Society of Arts, sitting in 1867, an Australian sheep farmer averred that during four months of the year he boiled down daily from ten to fifteen hundred sheep for their tallow, for which he received about £25 per ton in the colony and about £40 per ton in London. A bullock fetched from three to four pounds, a sheep of eighty pounds weight eight and sixpence, and salted legs of mutton of prime quality were worth three shillings a dozen.

New Zealand also, in 1882, went into the trade extensively, and with such success that in the second year of her venture she passed Australia, and has held the lead ever since.

New Zealand has the advantage that her pastures are close to the seaboard, while in Australia they are far inland. In the latter colony, too, there are periodical droughts, while the average temperature is higher, therefore not so suitable for killing and freezing. Perhaps, however, the chief feature is the fact that the New Zealand sheep are of the cross-bred variety, more highly esteemed in the English market than the merinos which Australia chiefly furnishes. The merino market is the north of England, in the coal and iron districts;

those engaged in less exacting physical occupations prefer lean meat. Frozen meat also comes to us from the River Plate in large quantities, and as it is of the same class as that arriving from Australia, enters into close competition with it.

A few figures may not be out of place in showing what enormous strides have been made, and where at least a third of us get the family joint from. During ten months ending in October of last year, New Zealand sent 1,075,145 cwts. of mutton and 62,006 cwts. of beef, New South Wales and Victoria 624,013 cwts. of mutton and 52,489 cwts. of beef. The amount coming from Queensland was not so large, only 16,394 cwts., but the quantity of beef imported from there was 389,821 cwts.

The River Plate was responsible during the same time for mutton to the amount of 727,773 cwts., and beef 63,836 cwts. Supplies of meat are also derived from other countries: from America, Canada, North Russia, Holland, and Germany; but the meat is in no sense frozen. It is technically described as "chilled"—all the treatment that is necessary for a short passage. America sent us 1,856,846 cwts. of beef in this way during the ten months, and Holland 182,115 cwts. of mutton. These appear to be the only "chilled" figures which will bear comparison with the frozen meat trade.

Of course, America, with her numberless hordes of cattle and her prompt and easy communication with the great European centers of distribution, is a very serious rival as far as the beef trade is concerned. Yet it would be difficult to set a limit to the expansion of our trade in beef with the colonies if it is remembered that in 1883 the total beef export of New Zealand and Australia combined was only 1,481 cwts., while the returns from January to the end of November last year were 392,132 quarters for Australia, 124,068 in excess of 1896, and 24,236 quarters for New Zealand, or 9,710 quarters in excess. Australasian beef, though salable enough, is not, however, as good as their mutton. When American beef is quoted on the maket at sixpence per pound, New Zealand and Australian will fetch from a penny three farthings to twopence and five-eighths.

The story of a New Zealand sheep designed for the London market may be very briefly told. It is taken from the run to the slaughter house, killed, dressed, and transferred to the cooling room. The skin and superfluous fat are retained; after ten hours' cooling, the carcass goes into the refrigerating room for thirty-six hours. Thence it goes to the storing room, and when it has been enveloped in its cotton "shirt" and labeled, it is ready for its journey over the sea. The steamers which bring the meat to us through the tropics have, of course, to be fitted with refrigerating appliances, and our sheep takes its place among thousands of others, some of the boats being fitted to carry as many as 70,000 carcasses at one time. There are eighty-eight vessels engaged in the trade, capable of transporting 6,700,000 sheep per annum. Arrived in the Thames, the barges come alongside the vessel, and the sheep is transferred to a cold storage depot. Here, as has already been indicated, it may lie for weeks, or for months if necessary, so that—an important commercial advantage—there is no necessity for immediate sale on a depressed market. Finally, to part company with our sheep, it finds its way to Smithfield market, or is dispatched by rail into the provinces. Having once left the cold stores, it will not be long before it reaches the consumer's table.

Figures are in themselves quite inadequate to express the vastness of this industry, which has sprung into being almost in the last ten years. You have to get into touch with the forces at work. At Nelson's Wharf they deal with 10,000 carcasses a day, and sometimes as many as 12,000.

A cold storage warehouse is a topsy-turvy sort of a place; you go up to the top of the building to get inside, and go down stairs to get to the ground floor. This is part of the system of insulation—cold air sinks, while warm air rises. By entering under the roof there is no irruption of warm outer air into the cold storage chambers, which would raise the temperature and tax the refrigerating machinery unnecessarily to bring it down again. Having reached the top by way of a lift, you find yourself in a bustle of activity, lifts and elevators taking in on this side, discharging on that. One side of the building is open to the Thames, another side to a small dock tributary to the river—and up come the carcasses cradled on endless chains or "sheep siphons," faster even, when at full pressure, than the hands above can deal with them, sorting them according to their quality and dispatching them to the Arctic regions below. At the side of the warehouse facing the street the process is reversed—up come the carcasses from the chambers, and down the lifts they go into the railway vans and trolleys waiting beneath. But if you wish to see this branch of the industry at its full height, you must be on the spot between eleven at night and six in the morning. It is then that Smithfield begins to make its wants felt to the tune, say, of five or six thousand sheep.

The temperature on this floor, so perfect is the system of insulation, gives you not the slightest idea of the rigors of the climate beneath. A preliminary taste of it may, however, be obtained by a visit to the inspecting room on the same level. Through this room every carcass has to pass before it is allowed to leave the warehouse. As the door slides back and you step in, you instinctively pull up your coat collar and feel for your gloves. The pipes which run round the room are covered three inches deep with hoar frost and the ceiling is incrusted with it. Everything sparkles with ice crystals in the electric light, and the frozen carcasses of sheep and sides of beef which hang from the roof are as hard as a nether millstone. The bones are, if anything, harder still; a frozen bone, with the weight of a quarter of beef behind it, will go through a five-inch board.

There are solid blocks of ice standing about, five or six huge cubes of it, with bunches of flowers and fruit frozen inside, to give the visitors a further taste of the marvelous. One of them has imprisoned a miniature model of a lamb, which, to the keen enjoyment of Nelson's Wharf, a journalistic wag set down on his departure as "the smallest lamb ever imported from New Zealand." It is, however, merely sharp, bracing weather here as compared with the floor beneath. There the temperature stands at twenty degrees Fahrenheit; yet another dip down, and it is four degrees less. For there are no less than five of these floors, each divided into three fireproof sections. In these the sheep lie piled on either side of you, one above the other, in "bays" twenty-three feet wide. A flock of a thousand sheep would take up some room on a country road, and be rather an unusual spectacle; there are one hundred and fifty such flocks stored in this one building, and it will hold two hundred and fifty thousand sheep at a pinch.

The elevators will deal with two thousand sheep an hour, the chains moving at the rate of 120 feet a minute; and from six thousand to eight thousand sheep come and go from the wharf each day in the week. The yearly average is about one million five hundred thousand sheep and lambs, one hundred thousand quarters of beef, thousands of legs and shoulders of mutton, and numberless cases of frozen kidneys, ox tails, ox tongues, and sweetbreads.

A natural inquiry enough is where the supply of cold weather comes from, and a visit to the engine house explains the difficulty. At the first blush it is not easy to understand how you can get frost and snow from so torrid a region. There are three or four roaring furnaces at work, served by mechanical stokers; the atmosphere would be unbearable but for the thick coats of insulating material with which the pipes are covered. And then, in the center of the engine room, you come across a small pipe thickly crusted with rime. Farther on, and there is the faintest possible smell of ammonia, and the secret is out. There are, roughly speaking, ten tons of ammonia circulating through twelve miles of pipes. The intense cold which reigns in the refrigerating chambers is produced by the alternate compression and expansion of this ammonia. Compressed and driven though the pipes, it passes through an aperture no larger than a pin's point, and is then allowed to expand again, withdrawing the heat from the atmosphere as it does so. The capacity of the two compressors used, expressed in terms of ice manufactured in the twenty-four hours, is no less than forty tons. All this cold would, of course, be soon lost and dissipated but for the system of insulation. This has been carried to so high a pitch of perfection that the refrigerating machinery has been stopped for thirty-eight hours and the temperature has risen no

A SIMPLE EXERCISER.

more than three and a half degrees on the lower floors.

Most of the meat leaves Nelson's Wharf in a frozen state, and takes its chance of thawing on the journey, or when it reaches its destination. But for those who are willing to pay a farthing more per pound there are what are known as the "defrosting chambers." It takes just about as long to thaw a sheep or a quarter of beef as it does to freeze it—that is, four days for the beef and two days for the mutton. The temperature is gradually raised, and kept dry by pipes of expanded ammonia running along the walls, to which all moisture is attracted and deposited as snow. Rapid thawing makes the meat unsightly and does not improve its flavor. It is impossible, as the meat passes from the defrosting chamber, to distinguish between it and the home-killed; experts confess that, cooked and placed upon the table, even they could not tell the difference.

In Australia to-day there are seventeen freezing works in existence, while in New Zealand there are twenty-two. They could freeze about seven millions of sheep between them annually. Queensland, in 1893, had the forethought to start freezing stores going at Gibraltar, Aden, Ceylon, Singapore, and other points of call. After all charges have been met, the Australasian farmer gets about twopence a pound for his sheep, excluding his receipts from the skin and fat. The cost of getting the animal slaughtered, frozen, and put on board is scarcely a halfpenny a pound; the cost of transit averages three halfpence a pound. The farmer, however, does not necessarily undertake the risk and responsibility of making his own consignments. There are generally speculators to be found who will save him the trouble and pay him twopence a pound on the farm.

The possible developments of the frozen food trade do not stop at beef and mutton. Hares, rabbits, turkeys, ducks, chickens, butter and fish have all been imported into this country in a frozen state during recent years. Rabbits, though only naturalized in Australia a few years ago, have multiplied so quickly that they have become a pest to the agriculturist. Still, they have given rise to a new occupation, that of catching and killing them for exportation. Large numbers of them arrived here in the spring of last year, and were stored till September. Put on the market then, they were eagerly bought up by the "gutter butchers," or costermongers, and found so much favor with their customers that they seriously interfered with the sale of the cheaper qualities of mutton coming from the River Plate and Australia. Victoria sent us, between January and October of last year, 114,977 cwts. of frozen butter, and New Zealand 62,456 cwts. The amount coming from the other Australian colonies was inconsiderable. During last year the question of shipping Australian butter back again was actually canvassed. The drought there was so severe that it was an open question whether larger profits could not be made by reselling it to the colonists than by putting it on the home market. It is interesting to notice that the consumption of butter and butter substitutes per head of the population of the United Kingdom is continually rising.

The principal source of our foreign poultry supply for some years past has been Russia, but Australia and New Zealand now intend to make a bid for popular favor. Large consignments may be expected in the spring, when English and Irish stocks are exhausted. There is talk in the colonies of sending to China for Langshan fowls, to France for Houdins, and to England for some of the native stock.—Good Words.

A SIMPLE EXERCISER.

The necessity of muscular exercise for the preservation of the health is conceded. Some kinds of exercise develop the muscles, while other varieties develop the brain. We illustrate a gymnastic apparatus for use in one's room, which appears to be very practical, ingeniously devised, and compact. It consists of two polished wood bars 33½ inches in length, which are secured at one end by ball and socket joints to circular base pieces fastened to the floor. By means of a footboard attached to them, a movement similar to that of rowing may be obtained. A stirrup pedal, with an upright handle bar, may be attached to one of the floor sockets, and thus the ankle and leg motion obtained in bicycling be had. Another pair of bars about five feet in length, with adjustable weights that may be raised or lowered attached, may be inserted in the sockets and used for the various chest-developing exercises.—Le Monde Illustré.

PERFUME PLANTS.*

The sense of smell (generally looked upon as being the one with which we can best dispense) is of great necessity and advantage to many in various lines of business, who have to undergo a regular cultivation of this sense: such as the perfumer, the tea merchant, the coffee merchant and many others who depend, in great part, for a recognition of the various wares upon their respective odors. The noted French writer Jean Jacques Rousseau has stated that the sense of smell is the sense of the imagination. He claims that recollections of the past, both mournful and joyous, are more readily conjured up by certain odors than by any other association. The sense of smell, moreover, very frequently guards us from inhaling impure and noxious vapors, from living in vitiated atmospheres, and consequently is of great importance in hygiene.

It has been well said that the degree of a people's civilization and refinement may be estimated by the odors indulged in. The more highly refined prefer delicate floral odors, as the rose, jasmine and tuberose; while other nations and individuals incline toward cinnamon, clove and spicy, heavy odors, citronella and the like; and those still lower in refinement's scale seem utterly indifferent, it being said of them, "Noses have they, but they smell not." They will live in an atmosphere thoroughly vitiated with the odor of foul liquors and still worse tobacco fumes without becoming aware of them, though intensely offensive to the more delicately nurtured.

The term "Perfume" brings us back to the origin of the use of sweet odors, which origin, in every case, was connected with religious usages. The Latin derivation, "per," through, and "fumum," smoke, shows that the perfumes used by almost all primitive nations were those obtained by burning odorous gums or woods. The primitive nations, grateful for fruits partaken of, felt bound to offer sacrifice, prayers and thanks to the deities believed to have dispensed them and always held to the idea that these thank offerings could be most efficiently conveyed to the residences of the gods by carriage upward on fumes of odorous smoke. All primitive nations, therefore, made use of incense gums of various kinds. This holds true of the old Israelites; of the Egyptians, where incense was burnt in every temple, on every altar, from Meroe to Memphis; the old Assyrians; even to the inhabitants of Thibet, a country deficient in odorous gums and forced, therefore, to rely upon juniper wood, or other odorous shrubs, as a substitute for the more valuable aromatic resins and balsams elsewhere employed.

In olden times these resins, and various kinds of incense, which at the present time are comparatively cheap, were excessively costly; so that we find numerous mention of their having been presented as most valuable gifts. One reigning governor would present to another a comparatively small portion of frankincense and myrrh, and it would be regarded as being equal, if not superior, to gold and silver; recalling to mind the presents made to the infant Saviour by the Magi coming from afar off—gold, frankincense and myrrh. These incense gums have not, by any means, been dispensed with, but are in daily use in the Roman and Greek churches, and among the Mahommedans, Brahmans and Buddhists in the far East. The early perfumers, or those who desired to use odorous substances, employed the products of nature just as they found them. They were able to obtain some of these gums simply by making incisions into the bark of the trees. In the hot climates where these drugs were produced resins often exude spontaneously without the trouble of making fissures. Next to these resins they employed various aromatic roots, barks and woods. The process of using the odorous substances became more and more refined, and various methods were devised for preparing compounds of them which were more permanent and less perishable. I would remind you of the formula for making the holy anointing oil which Moses was commanded to make by taking certain proportions of cassia, cinnamon, myrrh and

* Lecture by A. W. Miller, M.D., Lecturer on Materia Medica at the University of Pennsylvania. Delivered before the Botanical Society of Pennsylvania, November 11, 1898, and revised for the Scientific American Supplement by the author.

frankincense and heating these in olive oil; and also of the strong injunctions which were placed in connection therewith, prohibiting anyone but the priests attached to the temple from employing this holy oil. The punishment for its use was perhaps the greatest that could be inflicted short of the death penalty: namely, that of being cut off from his people.

Gum benzoin is, at the present time, largely and almost continuously used in the Greek Catholic Church. It comes from Siam and the countries adjoining; and is valuable to chemists because containing both benzoic and cinnamic acid. Some of the best varieties are said to contain vanillin. It is used in the manufacture of pastilles, complex in manufacture and diffusing a most agreeable perfume when ignited and the odorous smoke is allowed to pass through the sick room.

There is considerable doubt as to the true meaning of some of the terms applied to the odorous resins mentioned in the Bible: the Stacte and Onycha have never been definitely determined. Here is a resin called labdanum, by some authorities believed to be the stacte of the Bible. It is to-day very little employed. These are all natural productions, handled or manipulated only in the gathering and sending out into commerce. In ancient times they sometimes commanded more than their weight in gold. This gum myrrh was very largely used in ancient Egypt, in fumigations of all kinds. In the Temple of Heliopolis (mentioned in the Bible as the city of Om) incense was offered to the orb of day (known as the god Rā) thrice daily; in the morning resin was offered, at noon myrrh, and at evening a mixture of six different ingredients which were known as kyphi. The same material, also, was used for embalming the bodies of the dead. We can judge, to a certain extent, of the value attached to some of these gums by the fact that the records of some of the temples in Egypt—and especially the one in Upper Egypt at Dahr-el-Baheri—have representations and legends giving evidence of a fleet which was specially dispatched from Memphis down the Nile through a canal communicating with the Red Sea, to the Somali coast in Africa, chiefly for the purpose of procuring a more abundant supply of these precious gums.

Myrrh, olibanum and frankincense were regarded as most valuable of all; and the possession of a portion of these was esteemed most desirable for the rulers of Egypt. They were obtained from the east coast of Africa, and also from Arabia. Olibanum, or frankincense, is the one so largely used in the incense-burning of the Roman Catholic Church. Perhaps the most valuable of all the gums or resins is known as the balsam of Mecca, from the shrub Amyris. It is said that at the destruction of Jerusalem, the Jews, in their despair, destroyed all the Amyris shrubs, which were formerly very abundant about the mountains of Gilead. It is claimed that at the present time there are only a few of them left; and the product of these shrubs is reserved entirely for the use of the Sultan of Turkey. In the XV. century, after the discovery of America, when this balsam of Mecca had become exceedingly scarce and costly, it was found that a somewhat similar product was obtained in Central America—the so-called Balsamo negro of the Spanish missionaries. A small portion of this was sent to Rome; and it received the sanction of successive popes. Both Pius IV. and Pius V. promulgated special bulls giving permission to the Roman Catholic clergy to use this American product in the Sagrada Crisma and various other ceremonies of the Church. Balsamo negro is known to us at present as balsam of Peru. It is erroneously so called, as it does not come from Peru but rather from San Salvador, where a small district still has a number of these balsam trees standing; so that the particular locality is known as the Costa del balsamo, or balsam coast. This balsam is obtained in a rather peculiar manner by igniting a fire near the lower part of these trees, when the odorous substance is partly incinerated and, when in the liquid state, is mopped up by rags, which are thrown upon boiling water, so that the balsam can be sent out into commerce. This balsam was at one time sold in Rome at the rate of a hundred ducats per ounce. It enjoyed in the Roman Catholic Church a considerable reputation as an antiseptic and for the healing of wounds, before the purer forms of antiseptics were discovered. We have a somewhat similar substance known as liquid storax—the product of trees known to botanists as Liquidambar orientalis, occurring in the southwestern portion of Arabia, in the locality of Budrun, the Halicarnassus of the ancients. This tree is botanically very closely related to our sweet gum tree, Liquidambar styraciflua; and in confirmation of the close botanical relationship which exists between these two trees, it is found that when our American sweet gum tree is grown in some southern localities (as Arkansas), it can be made to exude a liquid known as the sweet gum; this is said to be entirely identical with the liquid storax imported from Arabia; so it can be used for the same purposes in medicine.

Liquid storax seems to be a sort of connecting link between the sweet and the foul smelling odors. Some people fancy a resemblance in the odor of storax to that of lilac blossoms; others, to that of the coal tar products, benzole and the like. This also suggests the query as to which odors are sweet and pleasant, and which of them are nauseating, or, at least, unpleasant. There certainly is a very great difference between the nasal organs of different nations and of different individuals. Here is a small specimen of asafetida—a substance which to most persons is exceedingly offensive; and yet there are persons who relish both the odor and the taste of asafetida. It is said to be rather a common thing for some of the French cooks in Paris, when preparing beefsteak à l'Anglaise, to take a bit of asafetida and stroke it across the gridiron before they broil it; also, that a certain variety of asafetida, intensely more offensive than the ordinary, is largely used in India as a flavoring in boiling one of their lentil-like vegetables known to them as dal.

Prof. Jno. M. MacFarlane, our genial chairman, relates the following as to native Indian asafetida: "It really doesn't seem to grow in India at all, but over an extensive tract away out in the wild parts of Afghanistan, on some of the elevated plateaus. Dr. Aitchison, of London, used to relate that in the British army of Afghanistan one would frequently see a tall Afghan take his cutlass and quickly lop across a giant asafetida plant about 8 to 12 feet high. Removing the upper part, he would start to chew a stick two or three feet long that he had retained as his choice portion. The most wonderful thing about this plant is its duration, and the relation it has to its environment. Dr. Aitchison said that the first time he accompanied the army into Afghanistan, they passed across what seemed to be a wild, wind-swept, and utterly desolate region. Even as a botanist he did not seem to think that the soil harbored anything in it. The army returned a few months after, and they all were perfectly amazed to find that when they reached this same wind-swept and cold region, they were crossing a forest of asafetida—few plants growing there except it. By this time the plant had reached a height of from 4 to 7 feet, although it was not quite in bloom. He was able, later, to see it in its full growth. Passing through the same region two months later they saw the last vestiges of the now dried asafetida being cracked to pieces and swept away by the wind after having been dried up and desiccated by the hot sun."

The well known valerian root (by most considered offensive) was at one time used as a pleasant perfume and in England (as the old chronicles tell us) to lay in drawers, where linen garments and linen were kept, to give them an agreeable odor. Valerian is exceedingly pleasant and agreeable to cats, which fairly revel in its odor. Macaroni is colored with saffron, which some people affect to regard as a perfume. It is said that the Mohammedan heaven has its floor made up of pure wheat flour, perfumed with musk and saffron. Saffron can be classed with the exceedingly heavy, rank perfumes. Nations living in southern countries are far more fond of strongly pronounced animal odors than those of more northern climes. All perfumes produced from flowers grown in the South are heavier and stronger than those from corresponding flowers grown in the North.

Among the odorous woods, that which is perhaps more largely used than any other in Eastern climates is the holy sandal-wood, the Santalum album of the druggists, consumed to such an enormous extent in the religious rites of the Buddhists and Brahmans that in China the tree has been practically exterminated. It is now grown in India (where there are large plantations of the sandal-wood trees) under the special protection of the British government. The trees are allowed to attain an age of twenty-five years, when they are cut down and their trunks allowed to lie on the ground. The white ants, so exceedingly destructive in Eastern countries, will not attack this sandal-wood, that is the viburnum, the core, the odorous portion; but they will readily destroy the sap-wood, the alburnum, which surrounds it; and after the tree has been peeled by the ants, within a comparatively short time, an interval of two or three weeks, the light-colored wood has been all removed and there is only the dark-colored core remaining. This is of value to the cabinet makers of the East, being largely used by them in making jewel cases, which are very valuable on account of being practically indestructible. These white ants will eat up almost every other vegetable tissue. The value of sandal wood seems to depend upon the proportion of essential oil which it contains, its presence there, in the proportion of about 1½ to 2 per cent., giving it a strong odor, agreeable to some persons, but very much disliked by others. The darker the color of the sandal-wood the better its quality, probably because it then contains a larger proportion of the essential oil. It is also then more valuable for medicinal purposes.

Sandal-wood has been frequently used in the construction of the most sacred buildings in India. There is an account of the gates of a temple at Gazpur, in India, which were elaborately carved and of great size, the two gates being about 11 feet square. The temple was destroyed about the year 1000 A. D., and these valuable gates were carried off into Afghanistan, where they remained for over eight hundred years. In 1842 the British troops reconquered this province and there found the ancient gates, which they did not send to the British Museum, but to the citadel of Agra, in India, where they are now most carefully preserved. The gates are over a thousand years old and apparently as good as ever.

The oil of sandal-wood may readily be obtained by distillation. It is rather rank and heavy in its pure state. Most of these perfumes are rather offensive in the pure form; and in very many cases, in order to retain their fragrance, it is necessary to highly dilute them. The use to which this sandal-wood is put in the East is that of being burnt as incense before the various images of Buddha, Brahma, and other divinities. In India it is said to be the proper thing, when a friend dies, for all those who have an interest in him to express their grief by purchasing a few sticks of sandal-wood and sending them to be consumed upon the funeral pyre upon which the body is burned. Joss sticks are made of powdered sandal-wood and of resinous substances more or less agreeable to the Chinese. The repertoire of Chinese perfumes is decidedly limited. They, of course, have musk (which is all produced or gathered in the western part of China), sandal-wood, patchouli, camphor, and asafetida. Asafetida is regarded by them as a regular perfume.

The well-known orris root is a decided perfume and very closely resembles the odor of the violet; it has, in fact, been used quite extensively by perfumers for the purpose of imitating violets, though at the present time there is a much better substitute in the artificial ionone made by the laborious researches of the German chemists. Orris root is largely grown in Italy and is the rhizome of the Iris Germanica and sometimes Iris Florentina. It is largely used with sandal-wood and other woods for the purpose of making the well-known sachet powders for perfuming articles of clothing, linen, etc. Curious fans and mattings are made in India of the root of an Indian grass, a species of Andropogon, known in India as kus-kus, in Europe as vitivert. It has a fibrous root, and it is the custom in India to weave it into mats and hangings, known in India as tatty. These mattings are suspended in the doorways, and during the intense heat an attendant is ordered to go around and sprinkle them with water. The root contains a proportion of essential oil of somewhat similar flavor with sandal-wood, but not nearly as large a proportion. It is present in little cells in the roots and held there in such a manner that it is practically indestructible. We may keep any of these vitivert articles for any length of time without apparent diminution of odor. The oil of vitivert can be obtained by distillation. The perfume known as Extract Marie Stuart seems to depend in the main upon the addition of a small proportion of vitivert oil, of which, also, the Bouquet Esterhazy is believed to be chiefly composed.

The resins, woods, and roots mentioned are not, by any means, all the different parts of plants that are used for the purposes of perfumery. The leaves of a plant (Liatris odoratissima) quite common in the South (and there known as Southern vanilla) are sometimes used in perfumery, their odor closely resembling that of new-mown hay. They are also used quite largely in the manufacture of snuff. Some of these plants have comparatively no or, if any, an unpleasant odor in the growing condition; and a certain kind of fermentation, or at least a drying, is necessary in order to bring out the peculiar odors. This is noticeable in connection with the sweet-scented vernal grass. While this has a peculiar odor in the flowering condition, it is inferior to and entirely different from the odor developed in the dry plant. The same thing holds true in connection with Southern vanilla, or deer tongue, as it is sometimes called. In South America grows a tree known as the Dipterix odorata, the seeds of which are exceedingly odorous, containing the same material known to chemists as coumarine. Tonca beans are largely used in snuff-making and by druggists to cheapen their vanilla extracts, as their flavor is somewhat similar to that of vanilla.

A sort of wild bean has lately come into the market from Tahiti, and while its flavor is inferior to the true Mexican vanilla and the Bourbon bean, the perfume, nevertheless, is, if anything, superior. They resemble the ordinary vanilla beans in appearance but are much cheaper in price and have a more delicate, floral odor, recalling that of the heliotrope.

A certain number of these odorous substances have been successfully produced by the chemists. I have here the odorous principle of the Southern vanilla and the sweet-scented vernal grass, and also of the Tonca bean. This is known to chemists as coumarine, and is now made entirely artificially. It is exceedingly concentrated, so that a very small portion of this coumarine will substitute a very large quantity of some of the plants that are passing around.

The first material which was used for the purpose of making this artificial vanilline was the rising sap in pine trees. The sap which rises in the spring of the year between the bark and the wood (the cambium layer) was found to contain a peculiar principle known to chemists as coniferine; then by certain adroit chemical manipulations they succeeded in converting the coniferine into vanilline. The first specimen coming to my notice was at the Centennial Exhibition of 1876, when it was sold at $40 per ounce wholesale. The patent expired in January, 1898; so that now it can be purchased for $1.75 per ounce, at which rate it is a very advantageous substitute for vanilla beans. This is not by any means a fraud, as the artificial product is chemically entirely identical with the vanilline of the vanilla beans. It is possible, and I think quite probable, that there is a slight difference in the taste of vanilline and the flavor of the vanilla beans; but this may be due to the fact that the vanilla beans do not depend for their flavor entirely on the vanilline, but may contain several other flavoring or perfuming substances, which would modify the flavor of the beans. One can appreciate the flavor by taking a small crystal and rotating it between the fingers, when the warmth of the hand will assist in the volatilization of the vanilline. It is now most largely made from eugenol or eugenic acid, one of the constituents of the oil of cloves, which was found to yield vanilline rather more readily than the coniferine. A third of these artificial products is heliotropine—the peculiar odorous principle of the heliotrope—the Heliotropium peruvianum. This is prepared at the present time from piperine, one of the constituents of the ordinary black pepper. Heliotropine very closely resembles the odor of heliotrope, which formerly was imitated by perfumers by mixing together rose, orris, vanilla, and several other substances, so as to approach the perfume of the heliotrope as closely as possible. The smell of the heliotrope flower is rather faint, the flowers are small, and for this reason it has never been practicable for perfumers to extract it from the heliotrope flowers to any advantage for practical purposes.

Still another of these eastern plants having a strong odor is the patchouly, the Pogostemon patchouli of botanists. There is a singular story connected with this. Many years ago it became possible, in the manufacture of India shawls, for the French to imitate the textures of India shawls so that the ladies were unable to detect the difference except by one point, namely, a peculiar odor which seemed to be inherent in the true article obtained in India and which the French manufacturers were then unable to imitate. The matter was of so much importance that the French weavers dispatched a trusted agent to India and Persia in order to make himself acquainted with the secret of the true India shawls; and he there found that the native Hindoo women, after they had laboriously finished one of these shawls, were in the habit of packing it away with leaves of a peculiar plant, somewhat resembling the sage in appearance. The agent was not very slow in supplying himself with an abundant supply of these patchouly leaves, and subsequently the French manufacturers were able not only to imitate the peculiar fabric, but also the peculiar, persistent odor. This patchouly is used as an article for making sachet powders and also in a number of compound handkerchief extracts. The true patchouly to some, either in the form of the leaves or the oil, is unpleasant. Many persons claim that it reminds them of musty, damp clothes. While this may be true of the leaves, it is certainly more true of the oil, but when patchouly is very much diluted (in the proportion of about a drachm to a pound), and particularly when it is sweetened to a certain extent by the addition of oil of rose or oil of ylang-ylang, it becomes more or less pleasant and is liked by many persons. The well-known "extract of white rose" has a small proportion of patchouly added to it, and its peculiar twang seems to be due to this addition of patchouly.

Lavender flowers have been largely used. The entire lavender plant, indeed, is frequently used to furnish the essential oil. The word lavender is supposed to have been derived from the Latin lavo, lavare, to wash, and is said to have been thus named from the fact that

the Romans used it for the purpose of perfuming their luxurious baths. Lavender is largely used for the purpose of making lavender water; as an ingredient in the well-known Florida water; and is also frequently used in making a number of other compounds of various names.

The more scientific methods of preparing the odors from plants consist, in the first place, of distillation. It is found that from almost all of those substances which contain an odorous principle, this can be removed by introducing them into a still, covering them with water, or passing steam over them, when the vapor of water will immediately carry away with it the odorous substance. If, on the other hand, the material is introduced into the still without any water, it is burnt and charred, and only a disagreeable-smelling tarry product is obtained. Almost all the essential oils are thus obtained. This is, therefore, one of the processes which is largely relied upon by the manufacturing perfumers.

The second process is by the act of expression. It is found that in some cases these little vesicles containing the essential oil are so near the surface that they can be ruptured by twisting the peel containing them. A fruit, such as the lemon, orange, or bergamot, is rubbed upon a funnel which has certain points projecting so as to crush the oil vesicles. The resulting pulpy mass is then expressed. The oil is very much lighter than water and is easily separated. The citrine odors are, all of them, made simply by expression. This applies to oil of lemon, oil of orange, oil of bergamot, oil of lime, oil of shaddock, and all those belonging to the fruits of the citrine order.

The third process is that known to the French perfumers as maceration. This consists in plucking the fresh flowers and throwing them into melted grease. Greasy substances of all kinds seem to have a singular affinity for the odorous principles of flowers and plants in general. In the south of France, in the vicinity of Grasse, Nice, Cannes, the so-called Maritime Alps, there are vast collections of flower gardens where hundreds of acres of flowers are grown on the most extensive scale for the purpose of being worked up into perfumery. The flowers chiefly grown there for this purpose are the rose, the orange flower, the tuberose, the cassie, and the jasmine. It is found that this locality has certain advantages which cannot be rivaled anywhere else. A great difference of climate is obtainable there by cultivating some of the plants at the level of the sea and then ascending the mountains gradually, so that any climate desired can be obtained. Cassie is found to thrive very well at the level of the sea. Higher up the orange flowers and the roses are grown; still further up the mountains the violets best flourish; still higher, the lavender, which seems to prefer a cold climate. When these flowers are in perfection, they are gathered in immense quantities and are brought to the manufacturing perfumers, of whom there are about one hundred and fifty in the little villages of Grasse and Cannes. They have rich, purified mutton tallow which has been melted, and the flowers are left in contact with and macerated in warm grease. The maceration is continued twelve to twenty-four hours; the grease is then strained from the spent flowers; the grease is again melted at as low a temperature as possible and an additional portion of flowers thrown into it. This process is repeated six, twelve, eighteen, even twenty-four times, perhaps, and a highly concentrated pomade is thus obtained. From these pomades the finest floral extracts are obtained by simply macerating them in deodorized alcohol. The alcohol, by reason of its superior affinity, withdraws from the grease the volatile flavoring extract, and the finest so-called French extracts are thus produced.

It is a singular fact that the odor of certain plants is modified by the processes to which they have been subjected. In the rose one variety of odor is obtained by maceration; a somewhat different odor is produced when the plant is subjected to distillation. The true oil of rose (of which we rarely see any) is made entirely in Bulgaria by some of the Christians in the Bulgarian provinces of Turkey. In the southern part of France the perfume of the rose is extracted by maceration. A certain number of these plants have so delicate an odor that they would be injured by the application of heat. The perfumers therefore resort to what they term reflowering, or enfleurage, which is practiced cold. The purified grease is spread upon trays of glass in a thin film only about a quarter inch thick, and the flowers are spread upon it and left in contact for twenty-four hours, when another layer is put upon it. This is done in the case of the jasmine and tuberose. In the case of the violet and mignonette, these pomades are made first by the process of maceration and finished by the process of enfleurage.

The Department of Agriculture at Washington reports that the losses of farm animals from disease and exposure in the twelve months ended March 1 last amounted to more than 7,500,000 head. On the basis of average values ascertained by the department in January, the loss from exposure amounted to $26,000,000, and that from disease to $49,000,000, a total of $75,000,000, "five-sixths of which," says the department, "is theoretically preventable." Commenting on these figures, the Chicago News says: "The theory of prevention is wrong in half the cases, and only $30,000,000 yearly of the loss is really preventable by means within the possible reach of the farmers and cattlemen; still, this smaller sum represents 5 per cent. yearly interest on $600,000,000, and few industries would bear so enormous a waste if it were possible to prevent it.

The London Lancet has been discussing the question of electric conduits bringing disease to the users of the electric light. It appears that in cases where the main cable is laid in a pipe beneath the footpath, the ends of the branch pipes for the house connections are left open, and a draught is set up into the house. This draught is due to the higher temperature of the houses, and as different temperatures exist in different houses, a communication is set up between them. Where one house is warmed with hot water, and another house is not so, a very considerable draught is set up. And where infectious disease is in a house, the germs may very easily be carried to other houses. It is suggested that the pipes should be plugged with insulating material.

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